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RECONSTRUCTION OF THE COMMON BILE DUCT

BY ALBERT J. WALTON, M.S., F.R.C.S., LONDON, ENGLAND
Assistant Surgeon, London Hospital

THE lesions of the gall-bladder and ducts which give rise to the greatest difficulty at operation are those where there is an irremovable obstruction of the common bile duct. Fortunately, in the majority of cases, this obstruction is slow in onset and is situated near the termination of the common duct. For this reason the dilatation of the gall-bladder and ducts together with the marked jaundice give a clear indication of the site of the lesion, and it is not as a rule difficult to determine whether the obstruction is due to a calculus, a stricture, or a new growth at the termination of the duct. In the latter cases a cholecystenterostomy can readily be performed and the obstruction thereby overcome. In certain cases, however, this operation may be impossible; for, owing either to an error of diagnosis or to the nature of the lesion, the gall-bladder may have been removed previously or the common duct may be obstructed or even destroyed to such an extent that the cystic duct is involved in the process. It then becomes necessary to perform an operation in which a junction is made between the distended duct and the intestine, or an attempt must be made to form a new duct out of some adventitious tissue.

From the technical point of view these cases may be divided into two groups.

In the first, the gall-bladder either is absent or is so small that it is valueless for the purpose of performing an anastomosis. There is an impassable obstruction to the passage of bile, but there is no biliary fistula. In such cases it is often immaterial whether the common duct persists throughout the whole of its length or is absent in part. The important factor is that the duct is dilated and generally to so marked a degree that it is not difficult to form an anastomosis between it and the intestine.

In the second group, in addition to the absence of the gall-bladder and the impassable obstruction, there is a biliary fistula, and hence the patent portion of the duct is of small size so that anastomosis becomes difficult or impossible.

The operation of anastomosis or choledocho-enterostomy was first performed by Riedel in 1881, a bilateral anastomosis being carried out between the dilated duct and the duodenum. The patient, however, succumbed owing to the leakage of infected bile. In 1891, Sprengel performed the first successful operation of this nature, having previously removed the gall-bladder. Since this date the operation of lateral anastomosis has not infrequently been carried out. In many cases, as in those of Czerny, Swain (24), and Fullerton (7), a Murphy button was used to effect the junction. In other cases the anastomosis has been performed by simple suture after the manner of a gastro-enterostomy, either with or without the use of clamps,

as in a case mentioned by Rowlands (19). Owing to the depth of the wound, at the bottom of which the anastomosis not infrequently has to be performed, it may be difficult to place the sutures so accurately that no leakage occurs. For this reason, Horz (11) suggests that the anastomosis, which is made laterally, should be performed around a rubber tube the lower end of which is brought out through a second opening in the duodenum and drained externally, the tube being removed on the eighth day. He states that thereby the chance of leakage is diminished and that after the tube is removed the small duodenal fistula rapidly heals. Experience of the troublesome nature of duodenal fistulæ in general would, however, lead one rather to doubt that so happy a result could be looked for in every case. Of late this danger of leakage seems to have been surmounted, for Sasse (20) advocates that the operation should be more frequently performed and should even be undertaken in cases of obstruction by a calculus, thereby allowing freer drainage to the duct. He opens the duct by means of a vertical incision, removes the stone, and sutures the edges of the incision to those of a corresponding incision in the duodenum. He reports ten cases in all.

It is in the second group of cases, however, that the greatest difficulty will arise, and an investigation of the methods which have at present been employed shows that they are far from perfect and are liable to give rise to complications. Two varieties of operation have been performed in which no attempt is made to reconstruct the common bile duct. The first group is that of hepaticoduodenostomy or hepaticojejunostomy. In this operation a portion of the liver is excised so that a raw surface is left which presents the cut ends of several small intrahepatic bile ducts. An opening is then made into the duodenum or, if more convenient, into a loop of the jejunum, the edges of the incision being sutured to the margins of the cut liver surface. It is hoped that thereby the bile will pass from the cut intrahepatic ducts into the lumen of the intestine. This operation has several grave objections. In the first place the bleeding from the cut liver surface is difficult to control; secondly, it is not an easy matter to suture the intestine accurately and firmly on to the cut edge of the liver; and thirdly, as in the case reported by Lameris (13), there is danger of infection spreading from the lumen of the intestine into the intrahepatic ducts. In his case the patient died five months after the operation, and although there were about ten openings discharging bile from the liver into the intestine there were multiple abscesses in both lobes of the liver. The other type of operation which is not directed toward the common bile duct is that of von Stubenrauch (25). In this operation, which was based on theoretical considerations alone, an attempt is made to form a junction between the intestine and the fistula. A loop of jejunum is divided and the proximal segment laterally implanted into the distal segment. The proximal end of the distal segment is now passed subcutaneously from the operation wound and implanted into the side of the biliary fistula. Even on theoretical grounds this operation has the objection that should the anastomosis succeed the bile will in part of its course continue to pass along a fistulous track which will tend to become stenosed. Of more importance than this, however, is the fact, as shown by the first operation carried out by this method and reported by Sutton (23), that not only may the biliary fistula not close but a fæcal fistula may be superadded.

The operations dealing directly with the common bile duct may be of three varieties:

1. The use of autogenous tissue grafts.
2. Direct implantation.
3. Indirect implantation.

Autogenous tissue grafts. Our present knowledge of tissue grafts is such as to lead to the belief that autogenous tissue can alone be used with any chance of success. For this purpose a variety of structures have been used, but the work on these lines appears to have been limited either to dogs or to the cadaver. Giordano and Stropeni (9) advocated the use of a portion of vein. Similar experiments were carried out by Giacinto and Luigi (8), a portion of a vein being used as a graft to fill an artificial gap in the common duct of dogs. The operation was completely

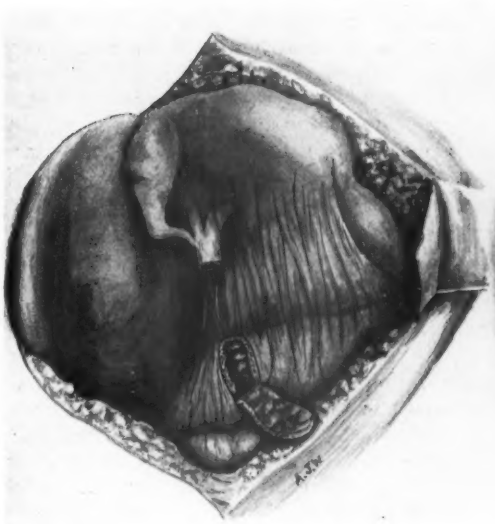

Fig. 1. Showing duct divided and opening made into duodenum.

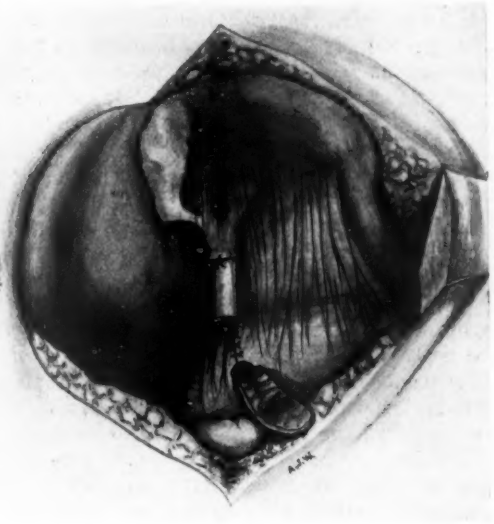

Fig. 2. Tube sutured in duct; opening in duodenum partly sutured.

successful, but in this case the difficulty of fashioning a suitable opening into the duodenum was not encountered, a portion of the common duct being left both above and below the graft. Danis (5), in order to test the value of vein-tissue for this purpose, grafted a piece of vein into an opening made in the gall-bladder of a dog. The dog was later killed and it was found that the graft had taken perfectly.

The use of the appendix has been suggested by Molineus (17), who advocates that this viscus should be removed from the patient himself. He has, however, carried out the operation only on the cadaver. If, as one believes, it is important that the appendix should come from the patient himself, the operation would labour under the disadvantage that in many cases the viscus would not be sufficiently healthy to form a suitable duct.

Lewis and Davis (6) have made use of portions of transplanted fascia from the abdominal wall to bridge gaps in the common bile ducts of dogs. At the end of two months the grafts were healthy and formed a satisfactory duct.

The operations above described may in the future prove of very considerable value, but at present, in the human body at least, it is difficult to say what is the exact value of such grafts. It may be found that neither the tissues of veins, of fascia, or even of the appendix may be able to withstand the action of the bile. In any case, such an operation involves the use of a somewhat difficult technique, for the suturing of the grafts has to be carried out often at a considerable depth from the surface and has moreover to be so adequately carried out that little or no leakage will take place from the line of suture.

Direct implantation. This operation was apparently first carried out by W. J. Mayo (16), who reported two cases, in one of which the common duct, and in the other the hepatic duct, was directly implanted into the duodenum. Similar operations have been performed by Packard (18), Harrington (10), and White and Lund. In Packard's case an ulcer was found occluding the duct at the papilla of Vater. The common duct was isolated and cut off from the duodenum. A puncture being made in another portion of the duodenum, the cut end of the common

duct was drawn through and sutured to the duodenal mucosa. The muscular wall of the gut was now folded over the duct in order that the latter might run an oblique course through the intestinal wall and hence have a valvular opening.

Wherever possible this is unquestionably the operation of choice, as no new tissue is employed to undertake the functions of the common duct. Unfortunately, however, it not uncommonly happens that the duct is not sufficiently long to allow of successful reimplantation. So large a portion of it may be destroyed that it cannot even be brought into contact with the duodenum, and much less is there sufficient to allow the formation of a valvular opening. In certain cases this difficulty may be overcome by implanting it, not into the duodenum, but into a loop of jejunum. Such a case as this was reported by Jackson (12), where an obstruction of the common duct together with a biliary fistula resulted from an operation for carcinoma of the stomach. The upper patent portion of the duct was dissected out and divided. The cut end would not reach the duodenum, and hence a loop of small intestine was brought up to it and sutured to the liver to relieve tension. The bile duct was inserted obliquely into it, the anastomosis being made around a rubber tube.

The small intestine should always be chosen in preference to the colon, for, as Weidemann (26) has shown, a junction between the gall-bladder and the colon in dogs is followed by a fatal ascending infection.

This operation, however, is not applicable to all cases, for it may not be possible to bring the loop of small intestine sufficiently high up without causing kinking of the large or small intestine.

Indirect implantation. This method is one which has been used to surmount the difficulties arising when a considerable portion of the common duct is destroyed and when it is found that neither the duodenum nor a loop of small intestine can be drawn sufficiently far up to allow of direct implantation of the duct. For this purpose some modification of the method advocated by Sullivan (21 and 22) is usually performed. He advised that a rubber tube be inserted into the stump of the hepaticus or choledochus and fixed there with an unabsorbable suture. The lower end of the tube is then inserted into the duodenum, the opening being made valvular by suturing the wall around the tube in the same manner as in a Witzel gastrostomy. The tube is then surrounded by a layer of omentum so that, if it be passed, a fistulous track lined by omentum will be left passing from the duct to the lumen of the intestine. Such an operation has been several times carried out. Brewer (2 and 3) reports one case in which the patient recovered entirely, but the tube was not found in the stools and it is doubtful whether it had been passed. A second case in a woman reported by the same author, died later apparently from obstruction. In both these cases the tube was wrapped round with omentum, but in neither case apparently was the opening into the intestine made of a valvular nature. Mann (14) also records a case in which two years after an operation of cholecystectomy it was found that the common bile duct was destroyed and the common hepatic duct ended abruptly. A tube was inserted into the duct, sutured in position, and the other end fastened into an opening into the duodenum after the Kader-Senn method of performing gastrostomy. The duodenum was then drawn up as close to the duct as possible. In this case also it was not known whether the tube had been passed, but five months after the operation the patient was greatly improved. Brandt (1) reports five cases from Wilms' clinic, these being the same five cases reported by Wilms (27). These operations were performed by Sullivan's method. In the first two cases a silk thread attached to the upper end of the tube led through the common bile duct into the duodenum and from there out through the abdominal wall. In the first case the tube was apparently left in place, the silk thread being pulled out alone. In the second case the tube was removed through the abdominal wound. The third case vomited up a second tube which had replaced the first one, which was insufficient. In the fourth case the lower end of the tube was inserted into the stomach and this tube also was vomited and

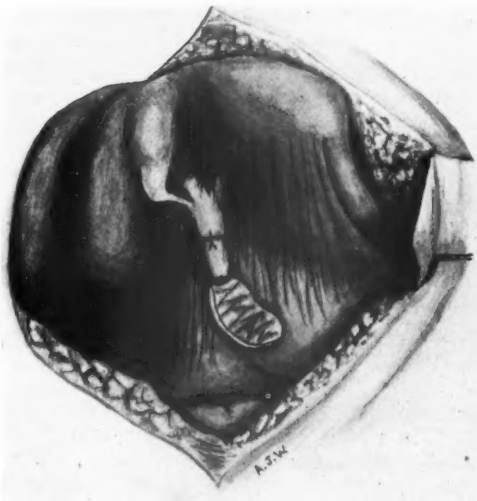

Fig. 3. Tube inserted into duodenum drawn up as close as possible to common duct.

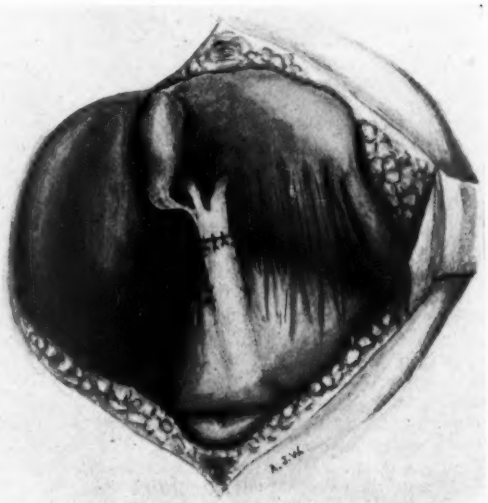

Fig. 4. The duodenal flap sutured around the rubber tube.

had to be replaced. The fifth case apparently made an uninterrupted recovery. The first three cases gave rise to a long after-treatment, the tubes being free in the peritoneal cavity and uncovered by omentum, but in the end all the cases recovered.

On theoretical grounds the objections to the above operation are, firstly, that the new duct is formed of omentum and hence is at best a fistulous tract. It is therefore very liable to stenose, a complication that probably occurred in Brewer's second case. Secondly, in order to form a firm wall to the fistulous tract, it is necessary that the tube be retained in place for a long period. For this purpose it must be fixed with an unabsorbable suture, and therefore may remain permanently in place, as probably happened in several of the above reported cases. One would believe that in such cases the tube would be very liable to give rise to infection, partly because its presence would lead to prolonged irritation and partly because, being rigid, it would prevent any opening into the intestine, however carefully made, from acting in a valvular manner. It is also fully realized that any foreign body in the gall-bladder or ducts is very prone to lead to gall-stone formation.

A consideration of the above objections led me to devise the operation which I carried out in the following case and which I believe to be free from these drawbacks.

J. L., age 27, a porter, was admitted to the hospital on May 9, 1914. He stated that eight years ago he had been jaundiced for about six weeks when a soldier in South Africa. The attack commenced with severe abdominal pain which doubled him up and lasted for four days. He had remained in bed for two weeks. He recovered from this attack and remained perfectly well until nine months before admission, when he again had a sudden onset of severe abdominal pain beneath the right costal cartilages and radiating from there to the back. The pain was continuous for the first day and was severe. It continued for the next four days, but was less severe. He vomited several times, but was never jaundiced. There had been no urinary symptoms. He recovered from this attack and remained well until eight days before admission, when there was another attack of pain, similar to the last, which lasted three days. The day before admission there was a less severe attack lasting only a few hours. In neither of these later attacks was there any jaundice. There had never been any dyspepsia and the pain had no relationship to food. There had never been hæmatemesis nor melæna and he had never had malaria.

On admission his temperature was 98° and his pulse 76. There was no jaundice. On examination the abdomen moved easily and no swelling could be felt. There was some deep tenderness in the region of the gall-bladder. His pupils were equal and reacted, and the reflexes were normal. The blood examination showed no leucocytosis and the Wassermann reaction was negative. A test meal showed 0.07 per cent of free hydrochloric acid, total acidity 45.

Operation, May 13, 1914. A five-inch vertical incision was made over the upper right rectus. The gall-bladder appeared normal and was not dilated. There was nothing abnormal to be seen in the stomach or duodenum. The common duct was not dilated. The pancreas was hard and there were a few hard nodules in the region of the common duct behind the duodenum. It was uncertain whether these were calculi in the common duct. The duodenum was opened, but the papilla appeared normal. The opening was therefore closed. The common duct was opened, but no stones were felt. A probe could not, however, be passed down to the duodenum. A diagnosis of chronic pancreatitis was made, but as the bile duct was not dilated it was decided not to perform cholecystenterostomy. As the probe would not pass down the duct, it would have been better to have done this. The common duct was closed with interrupted catgut sutures and a small drain inserted down to the opening. On the fourth day the tube was removed. A Cammidge "C" test was made and was strongly positive, thus supporting the diagnosis made at operation. On May 20, bile was flowing freely from the wound and the stools were clay-colored. This condition persisted until June 3, when it was decided to carry out a second operation.

The old incision was opened up and the gall-bladder was now found to be small and shrunken. Careful dissection showed the common duct ending abruptly about a quarter of an inch below the junction of the cystic duct. Below this the duct could not be recognized, being replaced by scar-tissue (see Fig. 1). A flap was cut out of the duodenum and turned downward (see Fig. 1). A tube was inserted into the end of the common duct and sutured in place with twenty-day chromic catgut. The opening in the duodenum was sutured in its upper part, leaving only an opening sufficient to admit the tube (see Fig. 2). The tube was inserted into this opening, the duodenum being drawn up as close as possible to the cut end of the duct with a catgut suture (see Fig. 3). The flap of duodenal tissue was now sutured around the rubber tube so as to make a new bile duct (see Fig. 4), catgut sutures being used. A small drainage tube was inserted down to the junction. On June 8, there was no leakage of bile from the wound, the stools were well colored with bile, and the drainage tube was removed from the wound. On June 14, the rubber tube was passed per rectum and the wound was quite dry. On June 22, he was discharged from this hospital, the wound being quite healed and there being no symptoms. On July 28, he was quite free from symptoms and his appetite was good. There had been no attack of the original pain. On October 27 he was seen again. He stated that being a reservist he had been called up to the army and for two months had been working hard at his military duties in camp. During this time he had been quite free from any symptoms. He has since gone to the front.

I believe that the above operation gives a simple and satisfactory method of dealing with these difficult cases. A new duct can be readily formed of practically any length. It is lined by mucous membrane, which is impervious to the action of bile, and being lined by such a membrane will show no tendency to contract. At the same time the opening passes obliquely over the duodenal surface and hence there will be a well-defined valvular action. Owing also to the presence of the mucous membrane, it is possible so to insert the tube that it can be passed without fear of complications in a few days' time, and no difficulty will therefore arise from the tube remaining as a foreign body.

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GUNSHOT WOUNDS OF THE LARYNX

REPORT FROM THE BATTLEFIELD IN RUSSIAN POLAND

BY L. BOEHLER, M.D., INNSBRUCK, AUSTRIA
Major Surgeon, Imperial Royal Division, Hospital No. VIII

POINTED bullets can pass through the neck without injuring any of the vital organs of this region. Very frequently we see men who have been shot from the front, from the side, and diagonally through the neck, who have not the slightest trouble. On the other hand we see men who have been shot suffering from injuries of the plexus, of the vessels, of the air passages, and of the œsophagus. In injuries of the vessels, surgical help is usually too late, as the victims die from hæmorrhage, a circumstance which I have often witnessed on the battlefield. The most terrible and tragic sight is the man who has been injured through the spinal column of the neck. He is totally paralyzed, and his upper extremities are so hypersensitive that he screams when you touch him.

The severest injuries to the air passages I saw when I was in the front line in the First Aid station, 800 yards behind the firing line (Schwarmlinie) as we call it, and the second time 1,200 yards back of this line and in front of our own artillery. The first case was a transversal gunshot wound through the larynx. Emphysema of the skin upward to the borderline of the hair and downward to the nipples was present. The soldier had great difficulty in breathing and was very blue. I immediately performed a tracheotomy, and the next day the emphysema receded. On the third day he had fever, and there was difficulty in breathing through the larynx, although the larynx was free. The soldier died, but I could not do a post-mortem because as I started to leave the house, it was hit by shrapnel and demolished.

The second case showed a very small point of entrance on the right shoulder and no point of exit. In this case, too, emphysema was present up to the hairline, extending laterally to the armpits and down to the border of the ribs. The eyes were totally closed. The lower jaw could not be distinguished and in front of the ears, the skin stood off in large folds. The soldier suffered severe attacks of suffocation and breathing was very difficult; he was dark blue, and had a very rapid pulse. When I cut through the emphysematous tissue, which was about five to six centimeters in thickness, the breathing improved. On laying the larynx bare, I found that the right side of the cartilage was perforated, and the flap about one centimeter square indented the larynx. Pulling outward of the flap with a stitch and tracheotomy was all I did. There was no point of exit on the left side of larynx, and the soldier must have coughed out the

bullet. The next day the emphysema was much smaller and he could open his eyes. Two days afterward I removed the cannula. Four days afterward I sent him back to the hospital with good breathing, a weak voice, but a normal temperature. That breathing before the operation was so difficult was due to the fact that the emphysema produced a great deal of pressure upon the little flap of cartilage in the larynx and acted as an obstruction. This flap acted like a valve and in that way the large emphysema was produced. The difficulty in breathing had already benefited when the pressure was relieved through the incision.

A third case was that of a soldier in whom the bullet entered three centimeters to the right of the larynx and in coming out produced, on the left side, a tear in the skin like a groove, running up to the border of the lower jaw. The injury must have been received while the man was lying with his head on the side, aiming. We found him four days after the injury. The small point of entrance was soiled and air passed through the opening while he was breathing weakly. There was no emphysema. His voice was very weak, and he had great difficulty in swallowing. Above the jugulum, I found an œdematous condition of the subcutaneous tissue and in the depth there was pus. We applied rubber tube drainage leading the tube out at the point of entrance of the bullet. The next day the temperature was normal. Four days afterward the wound cleared up, the voice was good, there was no pain, and the patient could turn his head. In this instance I saved a patient from mediastinitis by operating on the battlefield.

I was not quite so fortunate in a gunshot wound of the larynx which I once observed in the case of a suicide in whom the bullet entered on the left side but there was no point of exit. There was emphysema on the left cheek, and the patient had difficulty in breathing, and cyanosis. On the left side of the pharynx wall, there was a point of exit. Tracheotomy and gastrostomy were performed, but the next day the patient had a chill and died. Eight days afterward postmortem showed septic mediastinitis and emphysema on the right side. The bullet was in the fourth vertebra, having been located through röntgenization before the operation.

The last gunshot wound in the larynx which I observed, came to me two hours after the injury. He showed a small point of entrance half a centimeter from the middle line in the line of the incisura thyreoidea and a large exit in the posterior axillary line on the right side. He was coughing up considerable blood. In clearing the throat, a foamy bright red blood was expectorated; therefore, there must have been an injury of the larynx. There was emphysema on the right fossa supraclavicularis and around the point of entrance. The voice was only slightly weaker and there was not much difficulty in breathing. There was strong crepitation in the neighborhood of the scapula and no exudate of the plura, a very bad general condition, weak pulse of 120, cool extremities, straining at stool, yawning, and great restlessness. We wrapped him in warm blankets and gave him morphium. We prepared for tracheotomy in case he should begin to breathe with difficulty. Three hours later he died without any symptoms from the larynx. Post-mortem showed the entrance into larynx small on the left side to the incisura thyreoidea. The exit was on the right side between the larynx and the first ring of the trachea. The right lower horn of the cartilage was broken. The entrance inside was to the left of the false vocal chord; the exit between the false and the real vocal chord in the middle of the Morgagni pocket. The openings into the mucosa were very small and not much torn. In the larynx was foamy mucus. The jugularis, carotis, vagus, phrenicus, and recurrens were not injured. The tissue all around the right side of the trachea was suffused with blood. The clavicle was broken in the middle, the second and third ribs fractured, the glenoidal part of the joint was broken to pieces, but the head of the humerus and the nerves were not injured. The third rib had perforated the lung, but there was no severe bleeding in the plural cavity. There were considerable adhesions occupying a space as large as the surface of a hand in this region. The muscle of the heart was strong and the heart normal.

The injury of the larynx had also led to an emphysema, but it was not shown in the neighborhood of the injury of the lung and there was little difficulty in breathing during life. Although the bullet had passed between the vocal chords, none of them was injured and the voice was not very much impaired. The loss of blood was not too severe. The heart was strong, and no vital organ was injured. Was it shock that killed the patient? Possibly.

On the battlefield I found a dead soldier who had a defect about the size of a mark-piece on the front of his larynx, but no other injury. The injury seemed to have caused the man's death in a short time.

Two cases of injury from gunshot wounds in the upper part of the trachea and larger defects of the tracheal cartilage which were visible from the outside showed difficulty in breathing, but were not fatal. Since we had to move our first-aid station immediately after they came in, I lost track of these cases and could not make a prophylactic tracheotomy, as on the same day I had to take care of 800 wounded soldiers.

In another instance the bullet had passed five centimeters to the left of the middle line and in the height of the second tracheal ring, through the neck, and on to the other side just about as far from the middle line. It then turned outward and struck the clavicle and the right shoulder, causing a groove in the skin. The man coughed foamy blood, had a hoarse voice, some difficulty in breathing, and emphysema; but morphium and rest improved his condition in 24 hours, and he immediately recovered.

The first two cases were brought to me shortly after the injury and would surely have died without interference. The reason that we do not see severe injuries of the larynx is that the patients die before they get to us. Cases 5 and 6 show that these gunshot wound cases sometimes die through shock, even without injury to vital organs. The infection in Case 4 was in all probability due to the injury to the œsophagus, but I have seen another gunshot wound through the upper œsophagus which healed beautifully since we did not give the patient anything to eat or to drink. Case 7 shows that the larynx alone can produce a descending phlegmon. I never have had in a large number of injuries an œdema of the glottis. Dyspnœa and coughing up of blood were always the most prominent symptoms. Emphysema was always present except in Case 3 and might have disappeared in this case since he came into observation four days after his injury.

In all cases of gunshot wounds to the larynx and trachea in which great difficulty in breathing and a very extensive emphysema are present, an immediate tracheotomy is indicated, especially if the wounded have to be transported for two or three days in common wagons on poor roads and cannot have physician's aid during this time. However, if the point of entrance in the cartilage and into the mucous membrane is small a small dose of morphium and rest will bring about rapid improvement in the breathing. However, I have had to do tracheotomies many times on the battlefield in cases of injuries of the lower jaw and the falling back (swallowing) of the tongue for similar symptoms.

MILITARY SURGERY

By PROFESSOR THEODORE TUFFIER, Paris, France

THIS paper is a short review of what I have seen as Consulting Surgeon of the French General Headquarters, sent in succession to all the firing lines from Belgium to Epinal. Some of the time was spent in the base hospitals, but most of it in the first-aid hospitals at the front. The duties in the different zones may be briefly described as follows: In the first zone, nearest to the firing line, the lives of the patients are saved, in the second, limbs are saved, and, in the third, reparative operations are performed. But the three zones are very different in importance: what is done in the first reacts directly on the results obtained in the two others. Therefore it is necessary to have surgeons of the first rank at the front.

I. GENERAL CONSIDERATIONS

The projectiles in use at present are not humane. The shrapnel and shells are murderous. The German rifle bullets are not of the same material throughout; the outer covering is hard and when it comes in contact with bone it breaks and the nucleus of lead which it contains often leaves a long track of metal behind it. The severity of the wound is proportionate to the distance from which the bullet is fired; a bullet fired from less than 400 meters causes tremendous destruction, which is not proportionate to its volume or rapidity but depends often on the tissues with which it comes in contact. If it strikes a bone it breaks it into numerous large fragments, and there is an enormous wound at the place of exit. Sometimes we see holes as large as a fist where a bullet has come out, or even a whole upper jaw carried away, as was the case with a general whom I cared for. This would lead us to believe that they use a special explosive or dum-dum bullet, especially if such were found in the rifle magazine or catridge belt of the soldiers. I have never seen this, but I have often seen bullets turned base forward intended to be fired at close range and thus cause serious wounds. This explains the absence of a hard jacket on the base of the German bullet.

Injuries increase in gravity depending on whether they are made with rifle bullets, shrapnel, or bursting shells. The latter are particularly serious. The great majority of cases of tetanus and gaseous gangrene is due to them. The reason is that the fragment of shell always carries with it deep into the tissues bits of clothing covered with dirt, which is always septic and which contaminates the tissues without allowing of evacuation of septic products, and which cannot be reached by any antiseptic or lavage. From this we must draw the conclusion that if a wound made by a bursting shell is large enough to permit of access to the bottom of it, immediate extirpation should be performed. This is the advice that I have always given to the surgeons at the front.

It is important to know what areas are most frequently affected. Statistics from the operative zone of the different armies have shown that death on the battlefield is most frequently due to injuries of the skull or the middle or upper region of the thorax. Abdominal wounds come next.

The patients brought in by the ambulances most frequently have injuries of the limbs, and all of these may be considered infected. This is one of the facts that has been most definitely determined in all the zones of the Sanitary Service at the front, immediately back of the trenches, in the field hospitals, and in the base hospitals. It is a curious fact that during the first few months of the war we found wounds of the soft parts that were benign and non-infected, but now infection is the rule, and the dominant point in surgical therapeutics is the treatment of infection of wounds.

Unfortunately this question has not made any progress either in civil or military surgery, and we are just as poor in efficacious methods as we were at the beginning of hostilities.

Every surgeon has his favorite antiseptic, and they are all of the same value or nearly so. This is easy to understand, for all progress in modern surgery is due solely to *prevention* of infection. On the contrary when this infection is once established we are as helpless in combating it today as we were forty years ago.

We have two methods at our disposal for combatting infection of wounds: general serotherapy and local antisepsis. We have tried both. Antistreptococcic, antistaphylococcic, and polyvalent serums have not given any results. Antitetanus serum alone seems to have freed us from tetanus. I observed 120 cases of tetanus in all during the first few months of the war, and I have not seen a single case for months.

Have we a local antiseptic? There is none which really deserves this name. Whether we make use of tincture of iodine, dilute carbolic acid, sodium hypochlorite, hydrogen peroxide, or mercuric iodide, the result is the same; the suppuration continues. There is not at the present time any chemical product capable of suppressing infectious germs in the depths of a wound, and I do not know of a single example of a septic wound that has stopped suppurating as the result of the action of any chemical product whatever, applied to the wound or injected into the tissues. Each surgeon has his antiseptic formula. I have met surgeons in a number of ambulances and hospitals, each of whom boasted of his product, but on looking into the matter closely I have always found that their success was due to the *extremely attentive care* that they gave to the wounded, rather than to the product they used. A desire to demonstrate the superiority of their antiseptic led them to change the dressings more frequently and apply them more carefully.

This question, chief in importance, of the treatment of infected wounds necessitates a knowledge of the pathological physiology of wounds. At best we only know that the microbic flora of wounds is extremely rich in both aërobes and anaërobes.

At the meeting organized by Crile in March at the American Ambulance in Paris, and at the English Society of Medicine at Rouen, Wright, Carrel, and myself tried to solve the question. Wright tried to lift the veil and to show that there were causes furthering the vitality of the microbes in the products of wound secretion. The best method of neutralizing them was to arouse exosmosis by the application of a saline solution.

To neutralize a septic wound, it is necessary to find a substance that is bactericidal and not cytolytic. Carrel is carrying on research in this direction now, as we cannot neutralize the poison at present, but can only, as always, cause it to be absorbed or discharged. The application of gauze to the surface of the wound, a layer of hygroscopic cotton, and a bandage constitute the classical absorbent dressing that is used everywhere. It is possible to do better, however, and at present we practice continuous irrigation by the drop method with hypertonic salt solution by means of a simple device, which causes the liquid to traverse the wound. Despairing of finding a chemical antiseptic, we have returned to physical antiseptics: hot air and heliotherapy without dressing. These last two methods have given us remarkable results. A single surgical truth which has undergone the test of time remains fixed; that is, the *drainage of Chassaignac*, applied according to his principles, and with or without incision. The English surgeons were not far from the truth in taking as a maxim the saying which Godlee upheld: "Back to Lister." I must add as a matter of justice: "Back to Chassaignac."

In conclusion, immobilization and drainage are the true principles. Immobilization in fractures should be accomplished by means of plaster casts with handles.

Wounds in general may be divided into three great classes: simple wounds, anfractuous wounds, and gangrenous wounds.

For simple wounds the treatment is mechanical irrigation with hot water and the application of an absorbent dressing.

For anfractuous and irregular wounds incision, the same treatment is followed as for simple wounds. An important point is not to make the wound bleed during the dressings.

There are three forms of gangrenous wounds that may be met with:

Fig. 1. Apparatus for the forearm.

1. A simple local gangrene around the wound; this demands simple dressing while waiting for the formation of an eschar, or amputation above the gangrene. Freezing of the feet, really a gangrene, was a veritable scourge in November and December, and its victims were numbered by thousands. One fact, already pointed out in Manchuria and perhaps by Larrey, deserves special mention: That is "trench disease." I designate by this name trophic disturbances which may go as far as total gangrene of the fore part of the foot, and which is observed only in soldiers who have stayed in the trenches; it is due to humidity combined with slight cold. The temperature was not below 6 above zero and there was neither snow nor ice. It was first noticed among the Algerian sharpshooters in October by the physicians in the trenches; it was characterized first by a painful œdema, then an erythema and blebs on the dorsal surface of the foot, finally by cutaneous and deep gangrene. It receded as soon as the hygienic conditions were improved.

2. Gaseous gangrene, which in itself presents varieties that have a different prognosis and demand an entirely different treatment, depending on the cases:

a. Wounds with gas around the wound, making a veritable gaseous phlegmon. These yield to simple incision with a bistouri, irrigation, and a hot moist dressing, well dried.

b. Acute gaseous gangrene, the "bronzed phlegmon of Velpeau," which has already extended to the greater part of a limb, demands incision with the cautery or deep cauterization at points three or four centimeters from each other throughout the whole zone affected. This method gives good results, as does also injections of hydrogen peroxide, but on condition that the gas is located only in the subcutaneous tissues.

3. Fulminating gangrene which, within a few hours, affects the entire limb, and against which even amputation, the only treatment, is often powerless. It is probable that in this latter variety there is a special microbic flora, and probably an efficacious serum will be devised against it. *Perfringens* is one of the agents but it is not very probable that it is the only one, and moreover the fact that it exists in almost all wounds without gangrene would make it necessary for it to be absorbed or associated under peculiar conditions in order to play a preponderating part in these affections. At present it should be known that all these forms of gangrene are dependent on the presence of a foreign body, which must be removed, as it is the source of the condition. Serotherapy has not given any results.

There is also a curious variety of gangrene that I met with at the beginning of the war in the Vosges in an ambulance at the firing line of Rambervillers where I was with the Physician General Chavasse. It was an ascending gangrene without gas, progressing slowly, starting from a wound in the hand and foot and mounting slowly to the middle of the arm or leg. My first case was that of a wounded Frenchman, struck by a bullet which had passed through his wrist. He had remained five days in a wood into which the artillery fire prevented anyone from entering, without any help and without any other dressing than the individual dressing which he had applied himself. The gangrene, which was a black gangrene without any considerable increase in the size of the arm and slightly humid, kept mounting until it reached the deltoid region and necessitated amputation. The same day a German soldier was brought to me with a gangrene of exactly the

Fig. 2. Apparatus for the hand (fracture of the index finger).

same kind, which had advanced to the middle of the leg. He came from the same wood, where he had been injured by a bullet that had traversed the region of the astragalus, and he had been there five and a half days without any other care than his own individual dressing. His leg was amputated by one of our German colleagues who was a prisoner. Both of them had lived only on bread, thrown hastily to them by soldiers on one side or the other when they passed near them.

There remains for discussion the general course to be pursued in dealing with foreign bodies. It seems to me simple enough; they should be localized by X-rays, and their removal should depend on the symptoms or the degree of trouble they are producing. Their localization is particularly difficult in the region of the muscles of the shoulder and thigh. The directing needle of the Contremoulins method is indispensable in these difficult cases. The vibrator of Bergonié, which vibrates over the foreign body, gives remarkable results; and the electromagnet is used, especially at the American Hospital, for the removal of fragments of shells.

II. INJURIES OF SPECIAL REGIONS

We will take up now surgery of the different regions.

Injuries of the skull, so frequently fatal on the battlefield, may nevertheless recover spontaneously under conditions where this would seem most improbable. I have seen the brain traversed in all directions, from in front backward, laterally, and from above downward, without the patients showing any symptoms. I have seen a number of patients who had lost an amount of brain matter certainly as large as an orange, on the right as well as on the left, and in both frontal and occipital regions, who did not show any special symptoms. These cases, however, are curiosities. The treatment of injuries of the skull at present is as follows: Excision of the soft parts, extirpation of fragments of bone, and drainage without touching the foreign body at first. I estimate that at present we are getting 50 per cent of recoveries, but we must be reserved as to the final prognosis, for many of these patients die months afterward. In any case, immobilization of the patient as long as possible after a trephine is imperative. It is more dangerous to move a trephined patient several kilometers than it is to let him traverse that distance without a trephination.

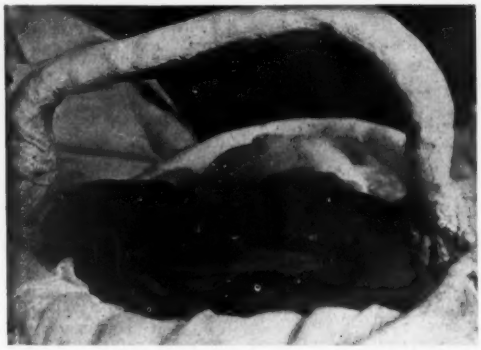

Fig. 3. Apparatus for the leg. All the median part represents the tibia laid bare and fractured at several points. The wound extends from the knee to the tibiotarsal joint.

The course to be followed is more difficult when there are symptoms of localization without any apparent fracture of the skull. In this case a trephine should always be done. It will reveal one of two things: either a fracture of the internal table with fragments of bone in the brain, or a subdural hæmatoma without fracture. Lumbar puncture, on which I have so often insisted, is then a good means of diagnosis.

I will mention in conclusion numerous cases of traumatic shock in the form of annihilation of cerebral functions, paraplegia, continued delirium, and of catalepsy,

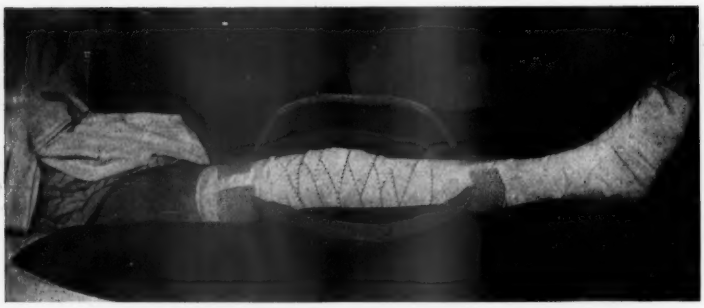

Fig. 4. Apparatus for the leg showing wire frame in place.

a number of cases which I have known to persist for a long time. They are almost always due to the bursting of a shell near the patient and are symptomatic of central lesions or of a preceding neuropathic condition. These examples of shock are abundant; for example, the case of a colonel of artillery, whom I saw wounded south of Saint-Dié. A large shell burst at his feet, and he disappeared under a mass of earth torn up by the projectile. We thought that he was crushed. He was found at a point 300 meters from where he had been wounded; his clothes were torn off, he was livid, pulseless, absolutely cold, and apparently moribund, covered with débris, and bleeding. He was picked up, undressed, the dirt washed from his skin, and artificial serum and camphorated oil injected. Little by little we found out that there was nothing the matter with him except multiple scratches and a little wound of the soft parts of the forearm. He was warmed, and two hours afterward he was conscious and had a very good pulse; the next day he got up. I could tell of numerous similar cases.

These distant nerve lesions are also observed in certain bullet wounds of the face. I saw four very clear cases in which a bullet traversed the face without touching the orbit or the optic nerve, and either one or both eyes were affected with retinal hæmorrhage, or a slight detachment of the retina.

Fractures of the maxilla are frequent and severe. Their treatment has made considerable progress since we have given it over to the dentists. Continuous lavage and bridges have given us therapeutic results of which we were ignorant before. The treatment lasts for months, but this is not too much to pay for the results.

Injuries of the spinal cord are much more serious. I have never seen in my own service or in any of the medical services at the front, all of which I have examined during the past eight months, a single case of recovery or even of survival for a long period after complete section of the cord. We may give as a fixed rule that the wounded succumb before the twentieth day, and the higher the wound is the quicker they die. On the contrary, incomplete, lateral wounds often allow of an indefinite survival, leaving a local sequela.

Injuries of the lateral part of the thorax generally heal absolutely like simple wounds; immobilization of the patient is the only condition to be fulfilled. But I should call attention to three facts:

1. To leave a foreign body is always serious, for it is rarely that it does not give rise to suppuration ultimately.

2. When the injury of the chest is accompanied by hæmothorax, recovery is always extremely slow; it may be prolonged for weeks or even months and during all this time slight febrile attacks may alternate with apyrexia, without suppuration taking place. Of course the latter necessitates a thoracotomy with resection of the ribs, injection of oxygen, and exercise of the lungs.

3. Successive punctures are necessary in these cases to relieve the patient; they give very curious results. I have seen a number

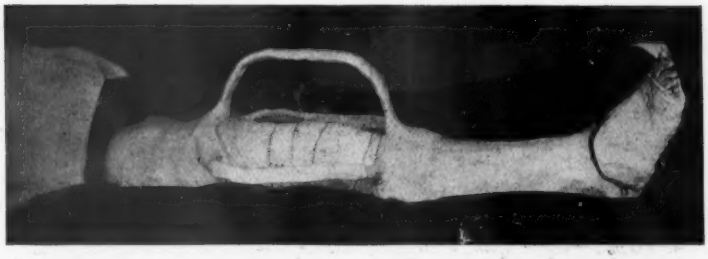

Fig. 5. Apparatus for leg completed. All the part situated below this line will be compressed when the plaster is dry. The parts of the apparatus may be too far apart, and they may be brought closer together with just as much solidity by using a simple hoop.

of effusions which looked absolutely like repeated secondary hæmorrhages. The first puncture made after a month produced an absolutely red liquid. Seven days later another puncture gave the same quantity of liquid of the same color, and so on for six weeks. We were justified in thinking of a repeated hæmothorax. Very much puzzled by these facts I analyzed them very closely and saw that it was not a hæmorrhage at all, for the liquid withdrawn at each puncture did not coagulate, even in the 24 hours following. Microscopically it did not have the composition of blood at all, and only contained a small number of red corpuscles. It was a serous effusion colored by the blood that had been effused previously. I studied with Milian all the pathological physiology of these cases.

Secondary hæmorrhages in injuries of the lung are rare. I have had only two cases, which I reported to the Surgical Society.

Injuries of the heart are very rarely seen. I reported to the Surgical Society the history of a French prisoner in Germany who, perfectly normal before his injury, was struck by a bullet which entered a centimeter from the left edge of the sternum and came out behind at the eighth left intercostal space. He presented after that, and still presents, all the signs of a serious loss of substance of the mitral valve.

There remains the always important question of wounds of the abdomen. It is one of the questions on which I count on seeing a great deal of progress in the present war. From the very first I took a personal interest in these cases. I took up patients at the front with penetrating injuries of the abdomen and transported them in automobiles to a neighboring hospital 10 kilometers from the firing line near Epinal, where I performed laparotomy. My results were bad: all the patients with injuries of the small intestine died. The question at present is to find out whether laparotomy is capable of giving satisfactory results in injuries of the small intestine.

We must distinguish carefully in these cases between hæmorrhages into the peritoneum, injuries of the large intestine and those of the small intestine.

In the very numerous medical reports which I have read in the course of my inquiries among the physicians of the armies and of the ambulances at the front, the conclusion has been the same; that is, that patients almost always die after laparotomy when there is a wound of the small intestine. I estimate that thus far in the whole French army there are not so many as twenty wounds of the small intestine which have recovered after operation. But simple wounds of the peritoneum and those of the large intestine give very numerous favorable results. Let us look at the matter a little more in detail.

The three methods are laparotomy with exploration of all the intestine, suprapubic incision, or expectant treatment. When the material conditions, operating room, rooms for the patients and personnel permit it, when they are in charge of a skilled surgeon and when the patient is brought in in time and in reasonable general condition, laparot-

Fig. 6. Radiograph of patient showing enormous projectile, a cartridge of a Lebel rifle.

omy remains the method of choice, but these conditions are rarely fulfilled. The Health Service in France has made great progress in reference to equipment, and movable operating rooms are installed at different points along the front, where all the conditions demanded in surgery in times of peace can be complied with.

Suprapubic incision is indicated when there is an abdominal effusion or where a peritonitis has developed and a laparotomy cannot be risked. The statistics given for this operation should be judged with some caution, for they profit by all the cases in which there have been no wounds of the intestine or where there has been simply a hæmorrhage into the peritoneum. Therefore, if we wish to compare the results of the two operations, we must accept for the latter only those cases which have been followed by a fistula of the intestine. I have shown that these cases are exceptional.

In all cases, drainage and the sitting position are imperative. Expectant treatment is a last resort, but it has good results in countless cases. For my part I have seen abdominal injuries, including one at the eighth left intercostal space and three of fæcal fistula that

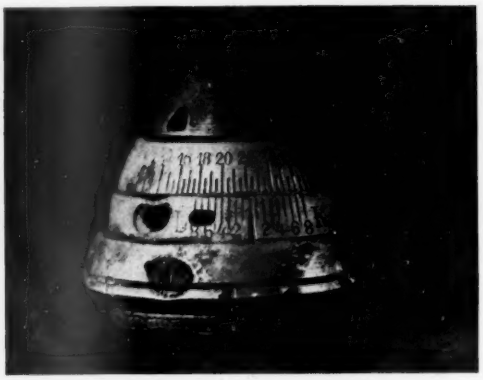

Fig. 7. Head of shell. The median line shows the distance from which it has been fired and which makes it possible to regulate the range.

recovered perfectly. In all cases where asepsis cannot be realized or where material or personnel is insufficient, recourse must be had to withdrawing food, immobilizing the patient in the sitting position, applying ice, and giving opium and subcutaneous injections of serum.

Injuries of the kidney are rare and not particularly serious. At Auxiliary Hospital No. 20 at Saint-Germain-en-Laye, I performed two late partial nephrectomies for urinary fistulæ due to lesions of the parenchyma of the gland; both recovered perfectly. I had to perform a total nephrectomy for a bullet wound of the kidney pelvis with encysted effusion, which I had previously opened.

Surgery of fractures, which had been so much neglected, has taken first rank in military surgery, because of its great frequence and because of the capital importance of its results to the wounded.

In surgery of the limbs two great principles dominate the treatment: every fracture is infected and every compound fracture should be completely immobilized.

Wounds of the tissues by bullets may reunite without suppuration, and therefore it is not necessary to incise and tampon them all; but the great majority suppurate and must be drained. This brings up the question of the conservation of the limbs and the best method of accomplishing it.

The hand and foot, more or less shattered by projectiles, should be preserved at any cost. I know too well the ineffectiveness of all artificial substitutes, particularly of the arm and hand, even to permit an amputation unless it is absolutely justified by the certainty that if it is not performed the patient will lose his life. Experience has shown me that the most scrupulous care, carried out in the most minute detail and perseveringly over long periods of time, will bring about conservations that one would have thought impossible and which justify us in always hoping. It is these cases of conservation that have given the most satisfaction to my surgical conscience. I consider amputation indicated only when I am convinced that without it the life of the patient is irremediably lost and that within a very short time. To put the thought in a paradoxical form I would say that the conservation of the limb has no limit except the patience and skill of the surgeon. Drainage, irrigation of the wound, cauterization if necessary, and, first and foremost, absolute immobilization of the two segments of the limb will lead to almost unhoped for recoveries in the great majority of cases.

I present herewith photographs of the apparatus which has given me unhoped for success; it is superior to all others that I have used. It must be watched; it demands time; but it insures idleness, that is to say rest and sleep, it makes dressing easier and less painful, and gives the greatest chances of recovery without septic complications. It is, as you see, a plaster cast provided with a framework of iron wire. I did not devise it, but I am a very ardent advocate of its use. It is made as follows:

Over the points of support, that is, the malleoli of the tibia and fibula and the internal and external condyles of the tibia, two small tampons of cotton should be placed, or better still, little rubber sacs filled with air, to protect the points of support. A flannel bandage is then wound around the whole limb to protect the skin.

This done, there are two ways of proceeding. On the leg, for example, a malleolar segment is applied and a tibial segment coming up to just below the knee, without compressing it. The fracture is reduced by flexion, and during this time the strip of metal that has been bent and prepared in advance, is placed between the two. A plaster band is placed around the juncture of the cast, and the metal, or better still a little oakum, is dipped into the liquid plaster and applied directly to the juncture of the metal part and the non-plastered part of the apparatus; this hardens and makes an excellent suture. With practice one can learn to make a very light and absolutely firm apparatus. Its firmness can be judged by taking the apparatus by the metal strip and moving the limb in all directions; there should not be the slightest sign of mobility.

It is very easy to make in this way an apparatus for progressive extension. In place of one metal brace two are used, corresponding exactly to each other and united in the median line by a screw. Loosening this screw moves the two segments of metal away from each other and thus brings about a true progressive extension. This latter improvement has only a few applications.

The question of apparatus is very much discussed. I leave aside the question of compound fractures of the leg, the fore-arm, and the arm. Immobilization in a good plaster cast or continuous extension in one of the innumerable forms of apparatus is sufficient for cure. Summing it up, first perfect immobilization and then coaptation is the line of treatment.

For the femur and the knee the question is much more difficult; account must be taken of the army zone in which the patient is located. At the front large zinc splints starting at the foot and coming up like a coxalgia apparatus, surrounding the limb which is covered with gauze, give sufficient immobilization and are the best apparatus under the conditions, but they are always inferior to a plaster cast well applied. This is the unanimous opinion of surgeons. But the difficulty of its application and the time it takes prevent it from coming into general use. In the second zone the plaster cast with handles is used. The results which it gives are absolute immobility of the wound, easy transportation, rapid dressing, and, consequently, rapid decrease if not disappearance of signs of infection. In the ambulances at the rear the best results are given by the Hamilton or Blake continuous extension or Tillot's simple apparatus.

But aside from the question of immobilization there is that of infection. In this respect unexpected results are given by in-

cision and drainage, leaving adherent bone fragments in position, and by continuous lavage, drop by drop with aspiration, as previously described. When the signs of infection have disappeared, then perfect reduction of the limb becomes the only care, but it must be remembered that suppuration and discharge, or extraction of fragments, may last for weeks or even months. During this long period of treatment, whatever limb is fractured, the most careful watch must be kept over the joints above and below the fracture, and they must be given the necessary movement, for there have been thousands of cases of stubborn stiffness of joints, very difficult to overcome and due solely to a too prolonged immobilization, often in a bad position. This mobilization should be accomplished by the patient's muscles themselves, not by mechanotherapy.

Amputation is only justified to save the patient's life, and we must have extreme patience with reference to infections, for they are often overcome after many weeks of septicæmia. The site of the amputation should also be selected carefully. Parts of the limb are sacrificed too willingly. Amputation should be performed as far as possible within the zone of the injury, simply leveling off the bone surface. I believe in this line of conduct because of the results of more than a thousand amputations which I examined at the Maison Blanche. There is a great difference between the results of an amputation of a leg near the middle third which gives good results, and one at the upper third, which permits of walking only on the knee. Worse still is amputation of the femur which leaves the patient absolutely infirm. Certain operations should be given up.

The examination of these thousand patients led me also to a curious conclusion and one which justifies what I said above in regard to infection. At present more than 60 per cent of the patients who have had amputations performed have had to give up their limbs a long time after the injury, not because of the extent of the wound, but because of a subsequent infection.

In injuries of the knee, aspiration by Carrel's method or continuous irrigation give good results; nevertheless suppurative arthritis with ankylosis is the rule in all cases where purulence of the knee leads to a reactive fever. Still it is not necessary to be hasty in amputation. Resection of the knee has given me remarkable results in these cases. As to foreign bodies in the joint, they should be removed immediately.

To finish this question I should mention that 8,000 of our patients who have had amputations performed have not yet been able to get artificial limbs of French manufacture, because the workmen are at the front and the raw material is lacking. We have been obliged to have recourse to the American factories to make up the enormous deficit produced by the conditions under which we find ourselves. In 1900 at the Exposition I had occasion to study this question as Reporter-General, and I made a comparative study of the apparatus all over the world. The question is most difficult with reference to the lower limbs. A good apparatus is one that is not too painful, but it necessitates a good stump, which is rather rare under the present conditions. As to the apparatus itself, it should be constructed primarily with reference to the work of the patient and the use he is to make of it.

Vascular lesions are frequent and present themselves under three forms: immediate or late hæmorrhage necessitating ligation, interstitial hæmorrhage, veritable aneurisms, which may become evident soon or late, and necessitate placing a catgut on the two extremities of the artery in the wound, and secondary hæmorrhage which necessitates ligation in the wound if it is aseptic and accessible, but if it is gangrenous or inaccessible, ligation in healthy tissue or beyond the wound. These ligatures are very benign and, except in aneurisms, are not followed by gangrene. I have ligated in this way all the large arteries, even to the subclavian inside the scaleni.

We will know later what is to be expected from surgery of the nerves. Two kinds of cases are presented. The nerve-trunk may be caught in a scar or callus. Freeing it from cicatricial tissue gives results that are often immediately favorable. But it is dif-

ferent with nerves that have been sectioned and sutured. Electrical examination during the operation is imperative. Only obliterating fibrous neurones should be resected. Suture should be with Carrel's thread. The operations have been performed too recently to know the results. In certain regions, such as the plexuses, I am convinced that suture should be performed immediately as soon as the lesion is recognized, and for the following reason: I operated late in a large number of these cases and I found a compact mass enveloping all the nerves, in which it was impossible to distinguish the branches that had been injured; and so of course I could not suture them. It would have been very different if I had operated soon after the injury.

During this war the most extraordinary injuries have occurred without causing any trouble. I have been shown bullet wounds that traversed the sternum from in front backward, laterally, and from above downward, without having caused serious symptoms; I have seen the thorax traversed laterally, from above downward, from the shoulder to the diaphragm on the right side and to the left axillary region, without any inconvenience to the patients.

I leave out of account these extraordinary cases, but I wish to cite three particularly suggestive cases: The first is in regard to the head of a shell, which is shown herewith (see Fig. 7) and which was extracted from the axilla of an Algerian sharpshooter. It enables us to regulate the range of our artillery by looking at the inscription on the shell which shows from what distance it had been fired.

The second is in reference to a wound by an incendiary projectile which exploded at every dressing. (See Case 2. I could not, unfortunately, furnish you a photograph of this shell, which I presented to the Surgical Society.)

The third is that of a French cartridge that had penetrated the brain of a wounded Frenchman. I cite the latter because it will give you an idea of the customs of this trench war (see Fig. 6, Case 3).

The transportation of the wounded remains to be discussed. In the beginning of the war when we were overwhelmed by numbers, transportation was defective. The patients were heaped into merchandise wagons and carried as far as possible into the interior of France; this was at the time of the retreat from Belgium. Little by little the service has improved, and at present I would divide it into two parts: the first from the moment when the man falls on the battlefield until he is put on a stretcher; the second from that moment until he enters the hospital. There is no improvement possible in the first part. The wounded must be looked for between the opposing lines at night and generally under the enemy's fire. They are then transported, either on the back of a stretcher carrier or held in his arms like a child, their bodies quivering and in the most deplorable and lamentable condition. Having been brought to the trenches they are carried out one by one generally seated in a chair, for a stretcher cannot turn in the narrow trenches. The distance to be traversed in this way varies from one hundred to six or eight hundred meters, and is the most painful part of the transportation.

As soon as they are on a stretcher they are dressed with an individual dressing — often a better dressing is put on at the dressing station — and then they are placed in an automobile ambulance. These are the carriages which give the greatest service; they come up as near as possible to the firing line, for they can carry the wounded away rapidly and comfortably to a hospital or railway station. There they are divided into two classes: those who can travel are placed immediately in trains where they are installed comfortably and carried away to the interior of France; the others are kept in the hospitals near the firing line. The latter class includes the injuries of the abdomen, injuries of the thorax, of the skull, fractures of the femur, especially the upper third, and all hæmorrhages.

All these posts demand skilled surgeons; the number available is certainly insufficient, for among our 16,000 physicians, more than 1,500 of whom are already incapacitated for work, there is only a limited number of

surgeons. The system in use at present supplements this number. It consists in having in a Sanitary group one surgeon who decides on the indications for operation, and who places a restraint on those too hasty amputations that were seen in the beginning of the war. He is aided by a number of operating surgeons, and, thanks to this system, a single experienced surgeon may take care of several hundred wounded a day.

This improvement, which seems very simple, was very difficult to bring about, but it has produced the best results, for it is true that, to carry out an operation correctly, a few months' study is sufficient, while to decide on the indications for operation one should have a surgical experience of years.

CASE 2. An Alpine chasseur wounded near Poperinghe by an incendiary shell had a fracture of the leg and a wound of the arm. When the wound was being dressed, and while they were removing the gauze that had been applied immediately after the injury, there was a small explosion with a flame, an explosion resembling the popping of a match, or rather of a firecracker, accompanied by a small puff of smoke with a strong phosphorus odor. While the wound was being cleansed with a tampon of hydrogen peroxide there was a series of little explosions lasting for about 30 seconds, all giving off a little smoke with the same phosphorus odor. Then the explosions stopped, but the odor persisted and the wound was examined. The whole limb showed considerable swelling and the tissues were black as if covered with soot.

Very much astonished by these phenomena, which he had confirmed by all around him, the physician renewed the dressing the next day, and there was again a series of crepitations with the production of a little smoke with a phosphorus odor. On the following days when the dressings were applied there were renewed crepitations and renewed vapors which always had the same odor of phosphorus. The patient died of phosphorus poisoning.

At the second dressing the wound was incised, and the surgeon removed from the muscular mass a fragment the size of a nut composed of a tube of rose-colored celluloid, two millimeters thick, and a mass of paraffin, all of which took fire from the slightest spark.

These fragments, examined by a technical committee from the artillery, were found to be made up of celluloid, paraffin, and lead oxide.

Physiological examination by the Faculty of Sciences of the University of Paris did not show phosphorous intoxication, which, however, does not prove anything.

This was therefore a wound by an inflammable shell containing phosphorus, which caused death by phosphorus poisoning.

CASE 3. A soldier, M, of an African batallion, injured at Somme, by a shell which burst near him, presented several injuries, one of them a fistulous wound at the internal angle of the left eye, a lesion that was apparently insignificant. The eye seemed normal, but the vision was somewhat disturbed. On looking closely there was found to be a slight erosion of the conjunctiva and a fistulous tract which discharged a little pus at the internal angle of the eye. The temperature rose, the patient complained very much of his eye and vision grew worse. At the internal angle of the eye abundant suppuration was found. It was decided to make a radiograph to find out whether a foreign body had penetrated the orbital region. This radiograph showed the presence of an enormous projectile, a complete cartridge of a Lebel rifle, which would not have been suspected at all from the entrance wound. The temperature continued to rise and the patient had a pronounced delirium. He was operated upon as soon as possible. It was seen that the eye was lost, there was a tolerably extensive lesion of the sclerotic, a burn produced by the hot projectile, followed by a scar, and by discharge of the vitreous body and panophthalmia. The eye being removed, we could see clearly the bottom of the cartridge embedded in the internal part of the orbit. After tolerably vigorous efforts the cartridge was extracted entire. Pus escaped through the gaping wound, and a drain was placed in the track of the projectile. The patient died two days later. On autopsy the whole surface of the brain was found covered with an abundant layer of pus. The projectile had traversed the internal wall of the left orbit, the ethmoid, the sphenoid sinus, and had pierced the anterior part of the right temporal fossa on the external wall of the cavernous sinus.

THE CAUSE OF TUBAL PREGNANCY AND THE FATE OF THE INCLOSED OVUM

By FRANKLIN P. MALL, M.D., Baltimore
Director of the Department of Embryology, Carnegie Institution of Washington

THE following report is based upon the study of 117 specimens of tubal pregnancy which have been collected during the past 17 years. A detailed account of these specimens will be presented in a well-illustrated monograph (No. 221), to be published by the Carnegie Institution of Washington.

CAUSE

A review of specimens, which is accompanied by data bearing upon the cause of tubal pregnancy, shows quite definitely that this condition is associated with inflammatory changes which must have preceded the lodgement of the ovum in the uterine tube. Under normal conditions the tube is lined with a layer of ciliated epithelium, which constantly works in the direction of the uterus and therefore creates in the tube a stream of fluid from the ovaries to the uterus. The fertilized ovum gets caught up by this stream and if the conditions are normal is carried into the uterus. Any change which delays the ovum in its progress will favor tubal pregnancy. It is well known that abnormal diverticula or duplicate tubes may be the cause of tubal pregnancy, and numerous isolated cases have been described in which a blind tube or large diverticulum contained the implanted ovum. In rare cases the blind inner end of the tube left after an operation is subsequently found to contain an ovum which has arisen from the ovary on the opposite side, which contained the corpus luteum, whereas only on the opposite side was there a passage free between the uterus and ovary. However, these anomalies are rare and cannot be viewed as the rule in cases of tubal pregnancy.

Much more commonly associated with tubal pregnancy is a chronic inflammation followed by adhesions and kinking of the tube. This has been repeatedly observed, but it is difficult to associate adhesions on the outside of the tube with the arrest of an ovum within its lumen. Whenever histories of specimens are given, it is frequently stated that there were numerous adhesions binding together the pelvic organs. It is also stated that tubal pregnancy usually takes place in women who have given birth to a child and then have been sterile for a considerable period. This fact is well known to gynecologists, and they are inclined to believe that the occurrence of tubal pregnancy indicates that the inflammatory condition in the tube, which prevents pregnancy for a number of years, is gradually disappearing, so that if tubal pregnancy had not taken place the chances are that the tube would probably have become healed in a few years, thus permitting the fertilized ovum to reach the uterus. This theory receives strong support from the study of numerous cases of tubal pregnancy. If the ovum within the tube contains a normal embryo, there is but little adjacent inflammation; if it contains a pathological embryo, the changes in the tube wall are usually marked; and when the ovum is well disintegrated, the changes are still more pronounced. Read in the other way, this would mean that if the inflammatory condition is nearly healed, the ovum implants itself in the tube and grows normally; but if the results of infection are still pronounced, the ovum rapidly disintegrates. Such an inflammatory process is signalized not only by an inflammatory reaction in the tube wall, but also by very pronounced changes within the tube lumen, the most common of which is a condition known as follicular salpingitis. The tubal folds hypertrophy, their tips becoming adherent, and, when sections are made, small cavities are seen between the folds; hence the term "follicular." Often this process is so marked that a section of the tube shows the folds as an extensive and delicate reticulum permeating the entire tube

lumen. In such cases the individual meshes of the folds have projecting into them numerous fingerlike processes, reminding one very much of a section of the intestine. While this process is at its height, it is clear that an ovum cannot pass through the tube, and much less can the spermatozoön pass outward to reach the ovum. It is only after this process has abated somewhat that it is possible to have conditions suitable for the production of a tubal pregnancy.

Another type of change differs markedly from follicular salpingitis, but in a way seems to go hand in hand with it. This condition may be spoken of as outpocketing of the epithelial lining. Here the muscular wall is thick and fibrous, and numerous small diverticula reach out into the muscular coat. Sometimes these are markedly distended at their blind ends. In other specimens they seem to run in parallel lines, indicating that instead of a single lumen we have numerous small lumina side by side. Either of these conditions would account for the arrest of the ovum. The ovum is taken up by the mucous membrane of the outer end of the tube, and owing to the impairment of the ciliated cells is delayed in progress. On account of this delay it grows too large to be carried through the narrow portion of the tube into the uterus. This condition would be aggravated when the tube lumen is greatly reduced at the uterine end, so we can easily postulate two kinds of changes to account for the two kinds of implantation so frequently encountered. When the ovum lodges at the outer end of the tube we should expect the outer end of the tube to be lined with fairly normal mucous membrane, but if the ovum is delayed in its progress and becomes too large to pass later through the uterine end of the tube we should expect to find the tube lumen reduced in size in this situation.

A third type of implantation usually takes place in the middle of the tube, and is the most common variety. In this type we most frequently encounter tubal inflammation and follicular salpingitis. It seems as though the ciliated cells can carry the ovum to the middle of the tube, but no farther. The ovum then implants itself within the folds of the tube, and soon becoming too large for the space it started to occupy; through secondary rupture is cast into the tube lumen. This process is always accompanied by considerable hæmorrhage, with marked distention of the outer end of the tube. In case the ovum is not aborted into the peritoneal cavity, it becomes larger and larger; it is encircled by a dense fibrous clot and disintegrates. Often the entire tube wall, which is thin and inflamed, has practically disappeared.

I intentionally do not take up the question of the nature of the inflammation which appears about a tubal pregnancy. It seems that, however, in certain instances this inflammation is due to the tightening up of an old infection that had occurred at the time of a previous labor, although the evidence points more toward venereal disease as a more usual etiological factor. The more frequent incidence of tubal pregnancy in cities than in country districts, and the frequent histories of gonorrhœa in these cases, point strongly toward the latter as the chief cause of tubal pregnancy. I do not believe that the evidence we have now warrants a more definite statement than this, as the subject cannot be determined by the histological picture. For the present, therefore, the question must still remain open.

TUBAL PREGNANCIES CONTAINING NORMAL EMBRYOS

In case the ovum becomes well implanted within the middle of the tube and ruptures into the broad ligament, conditions are brought about which favor the development of a normal embryo. Rupture on the free side of the tube would throw the embryo into the peritoneal cavity and therefore would probably terminate its life. The same is true when the implantation takes place near the uterus. Here the tube distends with difficulty. The ovum burrows into its thick wall and usually passes right through into the peritoneal cavity. I have numerous beautiful specimens illustrating this point.

In studying the specimens of tubal pregnancy, I arranged them in three groups to correspond to their contents; namely, (1) whether they contained normal embryos,

(2) pathological embryos, and (3) pathological ova. Each group was then divided into two subgroups, marked "examined" and "unexamined" respectively. The specimens have been arranged in this way to facilitate the study of them statistically. When embryological specimens were first sent me, only normal ones from tubal pregnancies were included, and this accounts for the large percentage of normal ones in the first 500 of this collection. For statistical purposes, only those specimens marked "unexamined" should be compared. In these cases the specimens were not selected by the surgeons who performed the operations, so that during a period of 17 years I have obtained 13 normal embryos, 20 pathological embryos, 47 pathological ova, among 80 unexamined tubal pregnancies. Thus it will be seen that of the pregnancies which were not examined before the specimens were sent to this collection, 16 per cent, or nearly one-sixth of the whole number, contained normal embryos. I am rather of the opinion that this is too large a proportion, inasmuch as the small tubes containing a small ovum were generally not sent me.

It seems highly probable that when the ovum is normally implanted and contains a normal embryo, it is attached to the tube wall much as the ovum is attached to the uterus normally. It burrows through the mucous membrane and makes for itself a space between it and the muscular wall. This process is accompanied by a marked hæmorrhage, probably much more pronounced than is usually the case for a uterine implantation. The trophoblast promptly attacks the venous sinuses of the tube, first growing around them and then into them, but there is no response in the tube similar to that which takes place in the uterus. In the tube, practically no decidua is formed; and as it seems that the decidua is an important factor in preventing extensive hæmorrhage, it follows that from the beginning the implanted ovum in the tube must be surrounded by an excess of blood. The blood which is in immediate apposition with the trophoblast does not coagulate and is taken up by the syncytium, which is usually very markedly vacuolated and serves as pabulum for the ovum. All stages of destruction of the blood-corpuscles can be seen in suitable specimens. Particles of red cells are found within the cells of the trophoblast, where they still take on their characteristic stain. Soon these particles become so small that they blend with the protoplasm of the syncytium, giving to it the tone of the staining property of the red cells; so we can find all gradations and colors from red cells to the well-stained syncytium without demarking sharply the blood pabulum in its digestion by the trophoblast. If the hæmorrhage is excessive the blood forms a clot; that is, the antibody produced by the trophoblast to prevent coagulation of blood acts only in its immediate vicinity and does not penetrate the larger mass of blood. This clot then becomes a foreign body and cannot serve further as pabulum for the ovum. As rapidly as the trophoblast punctures the venous sinuses of the tube it throws up a wall, so to speak, which prevents excessive hæmorrhage into the intervillous spaces. If the blood dribbles in slowly, it seems to serve best as pabulum for the ovum. Extensive hæmorrhages are prevented by the cells of the trophoblast, which soon change into vacuolated syncytium and thus seem to protect the intervillous spaces. The larger meshes in the syncytium take up groups of red corpuscles, which are held until they fragment and are taken up by the protoplasm in the process of digestion.

The trophoblast also has a marked tendency to produce a peculiar necrosis of the maternal tissues with which it comes in contact, producing the so-called fibrinoid substance. Apparently this is formed primarily in the mesodermal tissue of the mother, but the fibrin of the blood, the epithelial cells, and the free trophoblast do not seem to escape in this form of necrosis. With the aid of the fibrinoid substance a strong wall is formed between the tips of the villi and the tissue of the tube. This mass then forms a line of demarcation between the ovum and the tube wall, even if the latter be ruptured. The implantation cavity then is lined with much fibrinoid tissue upon which are scattered cells of the trophoblast. Later these individual

cells penetrate the fibrinoid substance, giving it in older specimens the peculiar appearance of cartilage. Tips of the villi penetrate this wall, and from them streams of active trophoblast reach out and puncture fresh sinuses. In every respect the condition found in normal implantation in the tube seems to be identical with that found in the uterus except that there is no formation of decidua. As the decidua may be viewed mainly as an agent to prevent excessive hæmorrhage, it can be spared in the tube in case the trophoblast and fibrinoid substance take its place. In fact, in the latter part of pregnancy in the uterus the decidua does not seem to play any great rôle.

Altogether 43 normal specimens in this collection were obtained from tubal pregnancies. The youngest specimen contains an embryo 4 mm. long, the oldest a fœtus 96 mm. long. It is interesting to note that the larger number fall in the sixth week; that is, our surgeon usually make a diagnosis during the sixth week of tubal pregnancy. No doubt many of the normal embryos would not have continued as normal specimens; for instance, in one containing an embryo 4 mm. long there already were pathological changes within the spinal cord. Others had ruptured and the embryo was found free within the abdominal cavity. Thus we could not expect many of these to survive through the full period of normal pregnancy. No doubt they would have succumbed in a variety of ways, but in what percentage it is impossible to determine. Of all those that survive, only one-fifth remain normal; the rest become pathological or turn into monsters, as shown by von Winckel's studies.

It is interesting to note the fate of 13 specimens, containing normal embryos, which were not examined before they were sent to me. No. 808 was unruptured and contained what appeared to be a normal embryo; nevertheless, upon careful examination after it had been cut into serial sections, it was found that a small portion of the spinal cord showed marked histolytic changes. These were limited exactly to the part of the cord giving origin to the motor roots, the dorsal part of the cord appearing to be normal throughout. No doubt had we examined all of the embryos which appeared to be normal we should have found slight changes in different parts of the body of some of them.

TABLE I

List of 13 normal embryos that came to the laboratory without examination or selection before the specimens were sent.

Cat. No.	Dimensions of Tubal Mass in mm.	Length of Embryo in mm.	Remarks
808	70x25x25	4	Unruptured. Histolysis of spinal cord.
706	55x15x15	6.5	Ruptured. Menstrual age, 3 weeks.
389		8	Aborted.
612	30x30x30	8	Ruptured.
597	20x10	9	Aborted.
535	60x55x50	11	Unruptured. Tube wall nearly destroyed.
670	35x30x25	12.5	Just ruptured.
728		15	Ruptured. Menstrual age, 9 weeks.
576	30x30x25	17	Unruptured.
431	60x45x35	19	Unruptured.
657	35x20x15	25	Unruptured. Menstrual age, 3 weeks. Tube evenly distended. Embryo may be atrophic.
183		28	Aborting. Tube evenly distended.
484	110x100x80	96	Unruptured. Tube evenly distended.

It is seen by glancing at Table I that only the larger specimens are unruptured, showing that most of those containing younger embryos came to an end through rupture of the tube. The larger specimens (e.g., Nos. 576, 431, 657, and 484) reached this stage of development because they did not rupture. In these the tube is evenly distended. In other words, only 4 pregnancies among 117, or less than 4 per cent, have survived. Only these are suitable for development to full term. We must look to this group for the specimens which become markedly deformed toward the end of pregnancy. According to von Winckel, four-fifths of the fœtuses are markedly deformed. Therefore the probabilities are that of 117 specimens under discussion only 1 might reach maturity as a normal fœtus.

TUBAL PREGNANCY CONTAINING PATHOLOGICAL EMBRYOS

Whenever the degree of alteration in the tube wall is pronounced and accompanied with marked infection, the ovum does not

implant itself well, and consequently the embryo does not develop normally but becomes atrophic and degenerates. The more severe this process, the more pronounced is the reaction upon the ovum; or in case it begins to develop normally, excessive hæmorrhage around the ovum detaches the chorion from the tube and strangulates the embryo within. It dies suddenly and shows no tendency to grow in an irregular fashion. Later it disintegrates

The pathological changes found in the tube appear in most of the specimens I have studied. First, there are marked outpocketings of the epithelial lining of the tube, with a thickening of the muscular layer. This condition, according to the study of my specimens, appears to be chronic, as it is not accompanied with any leucocytic infiltration. Secondly, an acute condition, which is more frequently found, consists of an hypertrophy of the folds of the tube, which subsequently becomes adherent, thus forming numerous small pockets in the tube, known as follicular salpingitis. The mucous membrane is swollen and infiltrated with leucocytes and there is often an extensive exudate. According to Werth, this condition is usually associated with gonorrhœa, and there is nothing in the history of my specimens which speaks against this opinion. The inflammatory process is more marked in those cases containing pathological embryos than when they are normal. In practically all these cases the tube lumen is present, sometimes as a large semilunar slit encircling the hæmorrhagic ovum and sometimes as a simple tube on one side of it. It generally remains open throughout its course, showing that in them, as well as those containing normal embryos, the implantation is interstitial. In general, the tube lumen is small at the site of the implantation and becomes larger on either side as the mass extends within and distends the tube lumen.

All of the specimens containing pathological embryos, whether examined or not before being sent to the laboratory, are arranged in Table II. I have also included specimens Nos. 825 and 874, which were assigned to the group containing pathological ova, as well as No. 808 from the group of normal embryos.

TABLE II

List of tubal pregnancies containing pathological embryos.

Cat. No.	Dimensions of Tubal Mass in mm.	Length of Embryos in mm.	Form of Body	Character of Change in Embryos
825	90x40x25	0.1	Nodule	Mesenchyme containing a few epithelial cells.
342	30x20x20	1	Irregular	Small remnant of a greatly deformed embryo at the end of a large umbilical cord.
554	50x20x20	1	Nodule	
874	80x30x25	1	Fragment	Chorion very active.
196	50x30x30	2.5	Greatly deformed	
396	40x28x20	2	Double vesicle	Tissues in active growth.
324	45x45x45	3.5	Rounded	Path. change in chorion.
697	55x30x30	3	Small body	Completely dissociated;—menstrual age, 10 weeks.
881	110x35x33	4		
808	70x25x25	4	Normal	Histolysis of ventral side of spinal cord in thoracic region.
477		5	Irregular	Markedly dissociated; menstrual age, 2 weeks.
567	55x30x25	5	Atrophic	Dissociated.
784	75x35x35	5	Dead; tube ruptured	Dissociated organs cannot be outlined. Menstrual age, 8 weeks.
838	27x23x29	6	Tube ruptured	Thoroughly dissociated; central nervous system can still be outlined.
729	20x10x10	8	Normal (?); tube ruptured	Cord fibrous. Menstrual age, 4 weeks.
846	85x40x30	8		Completely dissociated.
804	50x40x40	8	Disintegrated	Free cells fill a cavity 8 mm. in diameter.
882	60x45x40	8		
766	55x45x40	10		Complete dissociation;—menstrual age, 6 weeks.
685	70x60x50	12	Tube ruptured	Disintegrating; menstrual age, 8 weeks.
524	70x60x50	15	Tube ruptured	Embryonic mass seems to be composed of the cord.
307	40x40x40	20		Thoroughly dissociated, with secondary changes in cartilages.
478	85x60x45	22.5	Normal	Dead for some time; menstrual age 20 weeks.
314		24	Head atrophic	Tissues macerated, dissociated, and infiltrated.
479	90x70x70	80	Very œdematous Tube ruptured	Tissues œdematous with secondary changes and adhesions; menstrual age, 13 weeks.

The specimens are arranged according to their length, and it at once appears that

TABLE III

Varieties of ova obtained from tubal pregnancy compared with pathological ova obtained from the uterus.

Form and Age	Pathological from Uterus	Pathological from Tube	Normal from Tube
Vesicular forms	19	..	..
Without embryo or amnion	29	..	..
Without embryo	15	52	..
2d week	4	..	..
3d week	18	3	0
4th week	21	7	0
5th week	13	6	2
6th week	27	2	11
7th week	10	3	10
8th week	2	0	8
9th week	1	0	3
10th week	0	0	5
11th week	1	0	1
12th week	0	0	1
13th week	1	1	1
14th week	1	0	1
Total	162	74	43

among those containing small embryonic remnants we have nodular and vesicular forms. Then we have a group of larger embryos, which are irregular in form but atrophic. The tissues of these are also more or less dissociated. The third group consists of dead embryos which are markedly dissociated, some of which have fallen entirely into pieces. The change in these specimens indicates that the process was probably of short duration, as it is marked by extremely severe destructive changes.

A comparison of the 117 different varieties of ova obtained from the tube with 162 pathological ova obtained from the uterus is given in Table III.

Of the group of 13 normal specimens spoken of above, 8 came to the laboratory ruptured and 1 was in the act of aborting; another was about to rupture (see Table I). Of 25 specimens containing pathological embryos, only 6 were ruptured, showing again that ruptured specimens usually contain normal embryos. In other words, a live normal embryo is probably far more dangerous to the mother than a pathological one.

It is impossible to obtain any satisfactory data regarding the frequency of the different varieties of specimens obtained from tubal pregnancies. This fact was pointed out also by Werth, who, however, expressed the opinion that only a small number of tubal pregnancies live beyond the first month. Of those that become well imbedded in the tube wall,

TABLE IV

Fate of 100,000 uterine pregnancies.

	Pregnancies	Births	Abortion of Normal Embryos	Pathological Embryos	Pathological Ova	Monsters at Term
Number	100,000	80,752	11,765	4,330	2,718	615
Percentage	100	80	12	4.3	2.7	.6

TABLE V

Distribution of tubal pregnancies in first and second half of about 1000 embryological specimens collected.

Collection of Embryos	Normal Embryos		Pathological Embryos		Pathological Ova	
	Exam.	Unexam	Exam.	Unexam	Exam.	Unexam
1st 500 specimens	21	4	2	7	4	8
2d 500 specimens	9	9	0	13	1	39
1000 specimens	30	13	2	20	5	47
Total 117						

only a small percentage survive for any length of time, and probably much less than 1 per cent come to maturity. The chief difficulty in obtaining good statistics is that too few specimens fall into a single hand for study. Thus our own specimens are only numerous enough to indicate the probable proportions. It is even impossible to obtain figures regarding the frequency of tubal pregnancy. The number of operations in a given hospital compared with the total number of patients does not give us any index at all of the true percentage; in fact, surgeons express very different opinions regarding the frequency of this affliction in different districts. Some state that it never occurs in colonial countries; others that it is uncommon in rural districts; and others that it is frequently encountered in cities. A parallel here with the probable prevalence of venereal disease is at once apparent. Beyond this we cannot go at present.

In order to make comparison between the ova and embryos in tubal pregnancy and those obtained from the uterus, I shall first give a table that rests upon all available statistics, most of which were obtained from von Winckel (Table IV).

Considering only those specimens which came to the laboratory unexamined, we can

TABLE VI

Eighty specimens of tubal pregnancy which had not been examined before being sent to the laboratory.

	Pregnancies	Births	Normal Embryos	Pathological Embryos	Pathological Ova	Monsters
Number	80	0	13	20	47	0
Percentage	100	0	16	25	59	0
Fate of the 16 per cent		3.3		10.5		2.2
Percentage after redistribution of the 16 per cent of normal specimens	100	3.3	0	35.5	59	2.2

build up a similar table; but here instead of 100,000 cases to deal with, we have only 80. It is seen at a glance that the specimens with numbers less than 500 arrange themselves very differently from those with numbers over 500. There are about 1,000 specimens in the collection, and Table V shows the distribution of tubal pregnancy among the first 500 and among the second 500 specimens. It is seen that tubal pregnancies in the second 500 fall off markedly in normal embryos and increase greatly in pathological ova.

The unexamined 80 specimens arrange themselves in a table in which the birth column is zero. Sixteen per cent of the specimens of tubal pregnancy contain normal embryos, 25 per cent pathological embryos, and 59 per cent pathological ova.

It is probable that the 59 per cent of pathological ova would have disintegrated and disappeared in some way if they had not been removed by the surgeon. It is also probable that most of the specimens containing pathological embryos would also have disappeared. Then comes the question as to the fate of 16 per cent of normal embryos. A glance at Table I shows that most of them rupture or abort, but no doubt the few that remain within the tube may continue to the end of gestation, although some of them die and are aborted. In fact, Werth gives a case in which the skeleton of a very small fœtus about the size of a bean was found encapsulated within the tube lumen at the end of 13 years.

I have attempted to express in Table VI the redistribution of this 16 per cent in cases in which the fœtus continues to grow to the end of pregnancy, using as a guide the proportion of anomalies in tubal pregnancy at term as given by von Winckel. Of course this would not always be their fate, because most of this group die long before the end of gestation; but if this redistribution is made, it is found that of 100 tubal pregnancies 3.3 per cent would have reached birth, the pathological embryos would be raised from 25 to 35.5 per cent, and there would be added about 2.2 per cent of monsters. This row of figures can now be compared with the percentage of specimens obtained from 100,000 uterine pregnancies. If this is done it is apparent that the pathological action in tubal pregnancy is far more severe than upon the pathological ova obtained from the uterus. In tubal pregnancy the embryo is quickly destroyed, the ovum is easily detached and becomes necrotic, and is absorbed or aborted. A normal embryo eats through the tube wall, and many of them are also aborted. The appearance of a pathological embryo from the tube is much like that of one from the uterus, but the destruction of tissue is more severe. All this points more toward complete strangulation in the tube. The uterus appears to be a more favorable site for pathological embryos which continue to live. This variety is less frequently found in the tube. It is probable that all small monsters and pathological ova that remain in the tube disintegrate.

There is a marked difference between early and late monsters from the tube and those from the uterus. In the former there is a marked gap between these two varieties. In the uterus there is a finer gradation from one to the other. The conclusion of our study of tubal pregnancy regarding this point is that there is a break within the pathological group in the tube; thus we have the early stages in which the changes are very severe, and later stages which show special varieties but which seem occasionally to include specimens in which pathological changes must have begun very early. It may be that change in the spinal cord in No. 808 might have continued to the end of gestation to produce a spina bifida. Otherwise the tubal monsters at term must have arisen from specimens which

TABLE VII

Date	Author	Number of Specimens	Number of Monsters
1876	Henning	150	2 and 6 compressed fœtuses
1894	Orillard	6 (alive)	6
1893	Schelling	257	25
1891	Küchenmeister	43	7
....	Harris	45 (alive)	11
1901	Sittner	125 (alive)	36
1902	V. Winckel	13 (alive)	13
....	Kehrer	93 (uterus bicornis)	7

were normal up to the twelfth week. No doubt the normal specimens of the sixth, seventh, and eighth weeks are of the kind that produce monsters at the end of pregnancy, as described by von Winckel. In fact, there is every indication that No. 657 might have turned into a monster, as it appears to be somewhat atrophic.

I have been unable to collect any good data regarding the frequency of monsters in tubal pregnancy, but according to Joachimsthal they are very rare, and according to Leopold they are relatively rare, while Martin and Orthmann, Ruge, Olshausen, and Veit state that they are more common than in uterine pregnancies. It may be that the latter gynecologists confused early pathological embryos with older monsters, while the former did not. The line of demarcation between them is difficult to draw; hence the distinction is not frequently recognized.

Von Winckel has done us a service in collecting those fœtuses from tubal pregnancies which continued to live and were removed alive from the abdominal cavity. His fœtuses must have arisen from the 16 per cent of normal embryos found by me in unselected unruptured tubes. Eighty-four per cent of my specimens were so markedly pathological and so far destroyed that they could not possibly have lived until the end of pregnancy. Von Winckel's cases are especially valuable for determining the fate of the embryo that must have been normal before the tube ruptures; that is, during the first months of pregnancy. Von Winckel first gives the cases that have been published by others, as follows:

It is seen in this table that the percentage of monsters increases from year to year. However, von Winckel thinks that it is safe to say that one-half of the fœtuses in ectopic pregnancy are deformed, the most common deformity being defects of the hands and feet. He collected 87 cases (14 of his own) and found that in 57 of them the fœtuses were much deformed and in 12 were markedly monstrous. Among these there were 6 cases of hydrocephalus and 1 each of hydromeningocele, encephocele, anencephalus, omphalocele, spina bifida, and hyospadia. In addition, the head was found deformed in 57 specimens, the legs in 44, the arms in 35; in 12 there were club-feet, and in 4 cases amniotic bands. The placenta was usually deformed, sometimes multiple, broad and thin, or short and thick, and often very hæmorrhagic. In general, then, it is the poles of the body that suffer most, the head being deformed in 75, the legs in 50, the arms in 40, and the trunk in 4 per cent of the cases. But while it is clear that a good share of the difficulty is due to ordinary mechanical causes, in the 12 cases that were markedly monstrous these could not be the sole factor; for them we must hold the hæmorrhagic placenta responsible, a growth that could be included under what I have termed faulty implantation. Therefore, 14 per cent of von Winckel's 87 tubal cases which were normal in early pregnancy become monstrous, while in uterine pregnancies the percentage is below 1.

TUBAL PREGNANCIES CONTAINING PATHOLOGICAL OVA

Pathological ova without embryos are very frequently encountered. In our selected cases 59 per cent fall under this heading, while in specimens obtained from the uterus there are only 2.7 per cent. Moreover, in both sets the figures are probably much too small, as no doubt many of the earlier specimens are lost or overlooked. We have no good data regarding the number of ova which disintegrate early, but the study of comparative embryology warrants the conclusion that many young ova degenerate and disintegrate. I am informed by Doctor Huber, who has studied with great care much material

TABLE VIII
Pathological Ova

Catalogue No.	Dimensions of Tubal Mass in mm.	Dimensions of Ovum in mm. and Menstrual Age	Villi and Cœlom
154		10x10x10	Fibrous.
298		4x4x4 (3 weeks)	Fibrous.
361		10x10x10 (7 weeks)	Dense reticular and granular magma. Tubal abortion.
367		10x7x5 (2 weeks)	Dense reticular magma.
369		(3 weeks)	
378		12	Granular magma.
415	40x20x20	(6 weeks)	Villi, almost hydatiform.
418	50x25	7x4 (5 weeks)	Fibrous (Collapsed).
430	60x35x35	25x20x15	Scattered necrotic villi.
472			Scattered fibrous villi.
488		(5 to 6 weeks)	
495	30x25x25	12	Dead membranes.
507	50x35x35		
513	70x30x30	15x10	Fibrous.
514	15x8x8		Few degenerate villi.
515		15x12	Fibrous villi.
517	40x30x30		Granular mass in amnion.
519			Scattered villi.
520	60x35x30	5x3x3	Collapsed ovum.
539	40x8x8	10x6x6	Scattered villi.
540	50x16x16	2	Attached to fold.
553	50x23x23	5 (8 weeks)	Collapsed ovum. Many Hofbauer cells.
561	28x22x22	Collapsed (11 weeks)	Granular magma.
570	25x14x8	Collapsed (6 weeks)	Fibrous villi.
575	40x23x18	5	Necrotic and mucoid villi.
602	50x25x25	13 (11 weeks)	Degenerate villi. Tubal abortion.
659	30x15x10		Few villi.
673	16x16x16	6x3 (11 weeks)	Collapsed.
686	70x50x40		Detached ovum.
694	40x10	13x7x7	Fibrous and necrotic.
720	90x30	(7 weeks)	Mucoid villi.
726	60x40x30	(12 weeks)	Few villi.
734	50x25x25	Collapsed ovum (2 weeks)	Mucoid and necrotic.
741	70x50x40	18x6 (20 weeks)	Fibrous and necrotic.
754	70x25x15	2x1 (1 week)	Necrotic.
762	65x45x35	(6 weeks)	Necrotic (scattered).
765a	75x30x30	5 (8 weeks)	Necrotic.
772	30x30x15	(4 weeks)	Degenerate (scattered).
773	55x20x15		Fibrous (scattered).
775	70x40x35	Collapsed	Necrotic and fibrous.
777	75x55x55	5, collapsed (11 weeks)	Few necrotic villi.
787	40x11x11		Few fibrous villi.
794	60x20x20	None	Possibly a few trophoblast cells.
809b	60x40x30		Few necrotic villi.
809c	80x45x35	Collapsed (1 week)	Scattered necrotic villi.
815	50x30x25	Collapsed (5 weeks)	Necrotic villi.
825	90x40x25		Double ovum with quite normal chorion.
835	40x30x30		Few scattered fibrous villi.
874	80x30x25	Ovum broken (7 weeks)	Villi very active.
889	50x25x25	(6 weeks)	
891	60x30x30	Ovum 10x5	Necrotic.
892	90x45x45	(11 weeks)	Fibrous villi.

from rats, that some of the fertilized ova break down before implantation. The same seems to be true regarding the pig. We usually find more corpora lutea in the ovaries than embryos in the uterus, indicating that all of the ova do not produce embryos.

A glance at Table VIII, which includes all the pathological ova studied, shows that most of them are less than 10 mm. in diameter. Many of them are small because they are collapsed. At one time they were larger, but as a result of excessive hæmorrhage they became detached, and the collapsed ovum indicates that it is degenerating. Very few of them are in process of abortion and none of them have ruptured through the tube wall. The ova are simply being disintegrated. This is indicated by the pathological condition of the magma, which is densely reticular and often very granular. The wall of the chorion is degenerating and the line of demarcation between it and the cœlom is often obscure. Strands of cells extend from the chorionic wall into the cœlom, and the main wall of the chorion is often ruptured. The villi usually show a variety of degenerative changes of which the most common is fibrous, but often mucoid. The trophoblast is usually scanty or necrotic with disintegration of the

nuclei, forming nuclear dust. When this is liberated, it is scattered through the specimen. The dead villi are soon invaded by leucocytes, and also by adjacent trophoblast which feeds not only upon them but also upon necrotic masses of trophoblast. As the ovum collapses it also begins to break up. The villi are detached and scattered in the blood-clot. The isolated villi may continue to grow, in case they are capped by active trophoblast which continues to tap fresh vessels. As the blood-clot becomes larger the single villi are separated more and more, ultimately undergoing complete degeneration. In a few instances the whole ovum breaks into pieces. It first becomes hourglass-shaped, the two parts then separate, and in one case (No. 874) one part is aborting whereas the other part is near the uterus, where it is still growing actively. Finally, the villi practically disappear, the clot becomes smaller and organized. These very small clots which are found in the tube are composed almost exclusively of fibrin, containing a few small degenerating villi. At any time during this process the whole tubal mass may be extruded and bring the pregnancy to an abrupt end. In case this does not take place, the clot probably disappears entirely by absorption. My material does not warrant any statement regarding the ultimate fate of a small fibrous clot or of an excessive hæmorrhage in the tube, which contains within it a few fibrous villi; nevertheless, the suggestion that the latter may have some relation to hæmatosalpinx, hydrosalpinx, and pyosalpinx, is pertinent.

THE PYLORUS: OBSERVATIONS UPON ITS MUSCULATURE[1]

By P. E. TRUESDALE, M.D., Fall River, Massachusetts

PYLORIC insufficiency is a well-recognized barrier to the normal motor function of the stomach. Its causes have hitherto been ascribed essentially to ulcer or cancer. Hypertrophy and atrophy of the musculature of this region as accessory causes have not been recorded, nor have the influences of such changes been considered in the application of surgical principles to the treatment of lesions of the stomach.

Examinations of our resected pyloric specimens for ulcer, fifteen in number, have revealed the interesting fact that such changes do occur and often to a notable degree. The muscular coats of the pyloric end of the stomach and the pyloric sphincter muscle exhibit a distinct overgrowth in the presence of ulcer of the stomach or duodenum. The degree of hypertrophy appears to vary considerably and is presumably governed by the measure of activity on the part of this region of the stomach. Whereas, after gastro-enterostomy, with the stoma functionating well, the musculature of the pyloric end of the stomach, especially the pyloric sphincter, becomes atrophied and atonic. These variations in the musculature of this region are what one would expect to occur in muscle-tissue in other parts of the body during continued periods of excessive function and of extended rest. It remains for us to interpret the significance of these transitions. Obviously, they possess a physiological bearing of considerable meaning, but it is my purpose to deal with their relation to the more common surgical procedures of the stomach.

The failures of gastro-enterostomy have been measurably surmounted by an improved technique and a more judicious selection of cases. Nevertheless, when employed as a single procedure its career is even now admittedly uncertain, and a study of its disturbing sequences may prove valuable in determining whether or not the future operation of choice for ulcer of the stomach or duodenum should leave the stomach permanently with a single or a double outlet.

After excision or infolding of the ulcer, attention has been for the most part centered around the anastomotic opening. Its posi-

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tion in the stomach and jejunum, its dimensions, its angle, its suture line, etc., have exacted the most diligent research. A recent and distinct advance consists in a better choice of suture material as advocated by the Mayos (1). But this more or less continued variation in the technique of gastro-enterostomy would appear to indicate no small measure of dissatisfaction with its results.

The normal pylorus scarcely admits the tip of the little finger. The diameter of its sphincter muscle when hardened measures approximately 0.5 cm. It is plastic, but rarely does it yield to the dimensions of the average gastro-enterostomy opening. Artificial openings are made large because the small stoma appears to have been ineffectual. A stoma of moderate size would probably be adequate provided its efficiency were not embarrassed by a transition at the pylorus. The structure of interest here is the muscle bundle which embodies the pyloric sphincter. Like the muscular coats of the entire pyloric antrum, it is subject to the variations described above. Whenever the symptoms of pyloric obstruction dominate the clinical picture and the lesion is ulcer, either of the stomach or duodenum, we have observed an overgrowth of the muscle in some cases, reaching 1 cm. and more in diameter. The same specimens showed that the cicatrix of the ulcer played a relatively minor part in the process of occlusion. If these observations are confirmed by further study and by other investigators, an additional factor is produced in clearing up the cause of benign obstruction at the pylorus. At the same time we may possess a partial explanation at least of the immediate success of gastrojejunostomy and the gastric disturbances which recur months or years after operation. This fact in itself, that symptoms often return from six months to two years after gastrojejunostomy, lends weight to the theory of a gradual loss of muscular control at the pylorus following this operation. This deficiency results in a return flow of the contents of the duodenum into the stomach. Findings at secondary operations have confirmed this view. Furthermore, one is inclined to assume that patients who have acquired the greatest degree of muscle hypertrophy at the pylorus, as a class, obtain the most lasting benefit from gastrojejunostomy. The reverse, however, is not necessarily true, since it is generally known that the artificial opening and the pylorus may be functionating together, or the pylorus alone in the presence of a stoma, and the patient continues to remain well. However, there is always an unfailing hope on the part of the surgeon who does gastrojejunostomy for ulcer that in some way the pylorus will close and remain so, for the permanently good results following this blockade are universally recognized.

The cicatrix of an ulcer, especially in the duodenum, must rarely occlude the pylorus. Obstruction elsewhere in the intestinal tract, as from the ulcers of typhoid fever, for example, would be considered very unusual. It is obvious, however, that the œdema and engorgement surrounding the ulcer must share to some extent in the occlusion, but this process is transitory and is subject to prompt relief after gastro-enterostomy. One of our pylorectomies was done eleven days after gastro-enterostomy for an ulcer mass which, upon inspection, I believed to be carcinoma. The second operation revealed a marked improvement in the size and appearance of the tumor due to an amelioration of the inflammatory zone. This is an observation commonly made by other surgeons. Except in the presence of a neoplasm, then, permanent obstruction of the pylorus cannot be assured except by division or excision. Here it may be observed that the success of the Finney operation of pyloroplasty, when practicable, is generally conceded; and that Finney (2) in his operation divides the hypertrophied sphincter muscle completely and permanently. No doubt the logic of his operation is thus explained.

Whenever the pyloric sphincter is hypertrophied and no lesion can be discovered in the stomach or duodenum, the region of the gall-bladder and the appendix should be carefully investigated, for somewhere in the intestinal tract there probably exists a lesion to account for this secondary change which may be due to spasm of reflex origin, unless the hypertrophy is congenital, an anomaly which must be rare though not inconceivable.

May not the congenital pyloric stenosis now so frequently observed in infants be a partial stenosis and yet a permanent one? Into this class might reasonably be placed an occasional case of "spasm" of the pylorus, considered in infants to be due to improper feeding and not demanding surgical treatment. Most of these cases get well with appropriate food. Is their recovery always permanent? Scudder (3) has shown that the pyloric tumor in infants does not disappear after gastro-enterostomy. The overgrowth of muscle results in permanent closure of the pylorus. If this congenital deformity is one of degree, there follows the natural assumption that an individual who has had gastric discomforts so long as he can remember may have a partial stenosis that is congenital. The correlation of this lesion in the adult and the infant was originally based upon the pathological studies of Maier (4). Two of our adult specimens showed a fusiform overgrowth of the pyloric muscle corresponding to the arrangement of muscle-fibers in the congenitally hypertrophied pyloric muscle. In one of these cases the history of gastric disturbance dated to a period as remote as the patient could remember. "A history of indigestion since the patient was two years of age" was an impressive sentence in the history of a male adult recited in a large clinic recently where complete records are a feature. A possible appendix and a thickened pylorus were the sole evidence that in any way could explain the history. This is not an uncommon picture, and it is a disquieting admission that appendicectomy does not always achieve success.

Hypertrophy of the pyloric sphincter muscle may have a further significance. McCarthy (5), in an article on the "Pathology and Clinical Significance of Stomach Ulcer," writes as follows: "A few cases give previous histories which appear to be appendicitis. This coincident, if it be a coincident, is well worth considering, however, as a possible etiological factor. . . . Litthauer has produced ulcers which do not heal by the production of localized anæmia and destruction of the mucosa. . . . These clinical and laboratory experiences are sufficiently striking to warrant further study and experimentation in regard to the possible production of pylorospasm, gastric anæmia, hyperacidity and necrosis, or ulceration of the mucosa." The hypertrophied pyloric sphincter muscle would at least appear to be a link in this chain of thought.

Inhibition of the function of the pylorus results in atrophy of its muscular coats and of the pyloric sphincter. Whether this interference is due to adhesions of the pyloric end of the stomach to the parietal peritoneum and adjacent viscera or to a perfectly functionating stoma, or both, the ultimate change in the musculature will probably be the same. The importance of this alteration is apparent when, in a given case, the degree of muscular atrophy is so marked that the pyloric sphincter entirely loses its function of control. This is illustrated by the findings in one of my cases, a pylorectomy six years after gastro-enterostomy. The anastomotic operation had been done by a master surgeon. When I opened the abdomen, examination revealed the pyloric end of the stomach and first portion of the duodenum extensively involved in adhesion. The first portion of the duodenum could readily be invaginated into the pyloric end of the stomach with the thumb, so atrophied and atonic was the pyloric sphincter. An examination of the stoma showed some induration and redness around the suture line. Suspecting an ulcer here, I opened the stomach transversely at the antrum. The stoma admitted two fingers readily and the mucous membrane was normal throughout. The contents of the duodenum poured into the stomach through the dilated pylorus. The stomach was wiped out, the pyloric opening packed with a sponge, and the stoma observed. Nothing entered the stomach through this artificial opening. This observation explained the presence of bile in the test meal and an excess of 40 ccm. removed one hour after ingestion. Therefore relaxation of the pyloric sphincter is accompanied by a reversed flow in the duodenum, and the duodenal contents enter the stomach through the pylorus as in this case. This phenomenon is in harmony with the laws governing in-

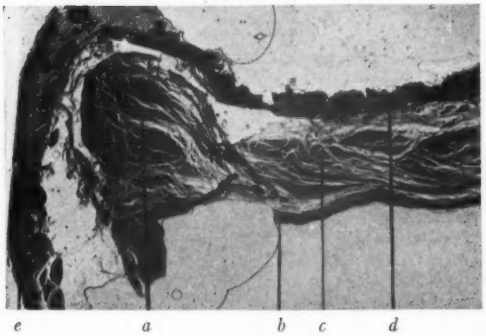


Fig. 1. Microphotograph of section through normal pylorus. Subject was a male, aged 45, who died of a cerebral tumor. No lesion was found in the gastro-intestinal tract. *a*, Pyloric sphincter muscle; *b*, peritoneum; *c*, musculature of the pyloric end of the stomach; *d*, gastric mucosa; *e*, duodenal mucosa.

Fig. 2. Microphotograph of section through the pylorus in the presence of ulcer of the lesser curvature of the stomach 4 cm. from the pylorus. Note the overgrowth of muscle. *a*, Pyloric sphincter muscle; *b*, musculature of the pyloric end of the stomach; *c*, œdema of the submucosa; *d*, gastric mucosa; *e*, duodenal mucosa.

testinal movements referred to in the researches of Cannon (6), Starling (7), and Nothnagle (8). Cannon (9) reminds us that the presence of acid in the duodenum closes the pyloric sphincter and an increasing acidity on the side of the stomach causes a relaxation of the orifice. Atrophy and dilatation of the pyloric sphincter, therefore, after gastro-enterostomy is enhanced further by acid in the stomach and an absence of acid in the duodenum. In the presence of this altered chemistry, there occurs a progressively increasing muscular relaxation and, ultimately, an inability on the part of the pylorus to maintain an intermittent closure.

The following cases briefly stated serve to demonstrate the influence of gastrojejunostomy upon the pyloric musculature with consequent disturbance of stomach function.

CASE 1. H. C., male; age 46; married; born in England. Family history and past history not remarkable.

Previous illness. Stomach symptoms for about twelve years consisting of distress two to three hours after meals. Occasional nausea. Rarely vomited. No night attacks. Food relief present. Bowels constipated. Decreased twelve pounds in weight. Test meal: No free hydrochloric acid. Yeast cells. No sarcinæ. Large bacilli. No leucocytes or red blood-corpuscles.

Operation, June 27, 1913. Posterior gastro-enterostomy for ulcer of the duodenum, and appendicectomy. He was symptomatically well for four months, during which time he regained his average weight. Digestive symptoms then began to recur. Distress two or three hours after eating. Vomited every morning. Lost fourteen pounds in the last six months. Medical treatment gave only temporary relief. Bismuth radiographs by Dr. Dodd of Boston. Writhing of duodenum noticed and stasis in the loop. Operation, April 24, 1914. Adhesions involved the pylorus. The pylorus was patent and atonic. The stoma was adequate and healthy. Von Eiselsberg's operation was done. One year after second operation this patient is symptomatically well.

CASE 2. J. M. B., male; age 40; married; born in Ohio. Family history and past history not remarkable.

Previous illness. In 1907 he was operated on in Columbus for acute perforated ulcer of the duodenum. Eight months later gastro-enterostomy was done. He was well for a year when symptoms, though mild at first, recurred. For the past five years he has had occasional attacks of indigestion lasting from two to three days with distress two to three hours after meals, promptly relieved by soda. He has maintained his average weight. For the past six months he has often been forced to wash out his own stomach, especially at night because of epigastric distress. There has been no vomiting but occasional nausea. Two weeks before his last operation stools were noted to be tarry. Long-continued periods of medical treatment only accomplished partial and temporary relief.

Test meal: Excess of 40 ccm. by the tube. Free hydrochloric acid, 25. Total acidity, 40. Much bile. Bismuth radiographs by Dr. J. H. Lindsey. X-ray diagnosis: Ulcer of duodenum. Stasis in the loop. Pylorus patent. Stoma functionating

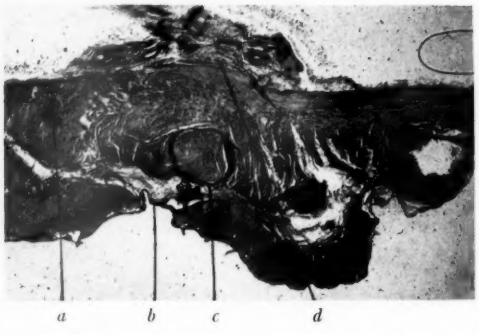
a *b* *c* *d*

Fig. 3. Microphotograph of section through pylorus and first portion of the duodenum. Ulcer of the duodenum. *a*, Contraction of peritoneal layer of healed duodenal ulcer; *b*, peritoneum; *c*, gastric mucosa; *d*, pyloric sphincter muscle showing marked hypertrophy.

well. *Operation*, February 20, 1915. Pylorectomy. There were dense adhesions of the pyloric end of the stomach to the parietal peritoneum. The pylorus was dilated and atonic, readily admitting the thumb. The suture line surrounding the stoma was considerably thickened. Suspecting ulcer I opened the stomach by a transverse incision. The stoma admitted two fingers and the mucous membrane was everywhere normal. Bile-colored fluid poured into the stomach through the dilated pylorus while nothing entered the stomach by way of the artificial opening. The pyloric opening was closed by a gauze pack and the stoma then observed. Nothing entered the stomach by this opening. Pylorectomy was done (Figs. 4 and 5).

a *b* *c* *d*

Fig. 5. Photograph of the pyloric end of the stomach and about 2 cm. of the duodenum removed 6 years after gastro-enterostomy. *a*, Duodenal mucosa; *b*, small crater of ulcer; *c*, pylorus, atrophied and widely dilated muscle; *d*, mucosa of pyloric end of stomach.



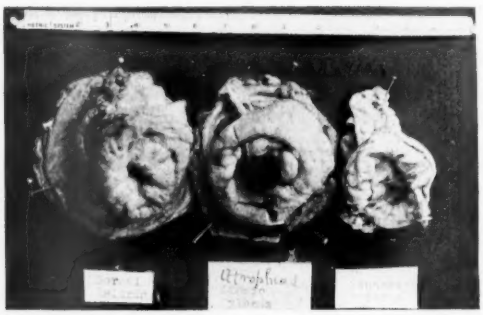
a *b* *c* *d*

Fig. 4. Microphotograph through the pylorus six years after gastro-enterostomy. *a*, Peritoneal layer; *b*, base of ulcer; *c*, atrophied pyloric sphincter muscle; *d*, omentum and infiltration over site of perforation seven years ago.

CASE 3. H. B., male; age 57; married; born in England; upholsterer. Family history and past history not remarkable.

Previous illness. Stomach symptoms began about 1907. He was in the Massachusetts General Hospital for observation in 1911, where diagnosis of peptic ulcer was made.

His symptoms consisted of distress two hours after eating, relieved by food or soda. Night attacks were common. Stools tarry. At times constipated. Operation, November 13, 1911. Posterior gastro-enterostomy for chronic ulcer on the superior surface of the first part of the duodenum; appendix removed. He remained well for two years when his ulcer symptoms began to recur and increased in severity until he was afraid to eat. During this time he had had medical treatment. There has been no nausea or vomiting. His weight has decreased twelve pounds since recurrence of symptoms.



a *b* *c*

Fig. 6. Photograph looking into pyloric lumen from the duodenal side. *a*, Normal pylorus; *b*, atrophied, atonic pylorus two years after gastro-enterostomy; *c*, stenosed pylorus from ulcer.

Operation, March 6, 1915. Dilated atonic pylorus (Fig. 6, *b*). Cicatrix of healed ulcer. Healed ulcer. Pylorectomy.

In presenting a summary of this paper, I am mindful of the limited number of specimens studied; of the wide variations observed in the degree of overgrowth and atrophy of the pyloric muscle, and of the difficulties of precise interpretation of these phenomena in relation to clinical events. Nevertheless, the evidence thus far obtained demonstrates that:

1. Hypertrophy of the musculature of the pylorus, especially the pyloric sphincter, is found in the presence of gastric and duodenal ulcer.

2. The hypertrophied muscle is a factor in obstructing the pylorus.

3. Atrophy of the musculature of the pylorus is a sequence of gastro-enterostomy.

4. Progressive atrophy of the pyloric muscle often defeats the success of gastro-enterostomy.

5. These changes in the musculature are the result of varying periods of excessive function and of extended rest.

6. Hypertrophy of the pyloric sphincter muscle may be of congenital origin.

For the pathological specimens and many valuable suggestions in connection with this study, I am indebted to Dr. Annie C. Macrae.

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Discussion

By Dr. Murphy and Dr. Einhorn

Dr. Frederick Murphy, St. Louis: This paper, I think, opens up a very important and relatively new field of observation. The reader has centered our attention upon the really important section of the stomach. With these details, namely, the hypertrophy and atrophy of the muscle layers, I have no observations to present for comparison, but it seems to me a very fertile field for investigation and we shall certainly try to confirm or disprove these observations. They may offer, I believe, true explanation for failures which we find in certain cases in the post-operative behavior. As a result of hypertrophy of the pyloric musculature which we see at the time of operation, we have obstruction; then, with the final atrophy, we again have the pylorus reopened and our vicious circle reëstablished. This muscular plane may play a more important part than we think it has in the past.

One statement I greatly appreciate: that the results of gastro-enterostomy without obstruction of the pylorus are at least uncertain. That impressed me as a fair, honest statement of the conditions which the average man finds. It certainly coincides with our cases in the Middle States.

In the cases where there is frank obstruction at the pylorus, gastro-enterostomy gives brilliant results. In the cases where there is no such obstruction, our results are extremely disappointing.

The idea that the gastro-enterostomy is a panacea for all lesions of the stomach seems to me to be absolutely in error, and not to be in accordance with the facts as men generally observe their cases, if they follow them sufficiently long.

In these cases which the doctor has shown, I believe there is instituted a very logical treatment of the lesions which are non-obstructive. In the first place, an absolute obstruction of the pylorus is made, and in the second place the dangerous area of the stomach is removed.

Of course, it is going to take a deal of experience and a very careful analysis of cases to warrant the statement that the percentage of malignant degenerations is sufficiently high to warrant pylorectomy in all cases of ulcer of this region. We had some twelve cases, I think, in which the results have been admirable, where the ulcer has been non-obstructing and where the entire pyloric end has been resected and the old gastro-intestinal canal reëstablished by some such operation.

Dr. Truesdale did not have the time in his paper to go into details, but had he had the time I am sure he would have emphasized the difference between lesions of the stomach and lesions of the duodenum. It seems to me that that is one point which is too often lost sight of.

In the region of the duodenum we have changes resulting either from the scar or the spasm. We do get our obstruction, and therefore the gastro-enterostomy gives, in every one's hand, relatively good results. In lesions away from the pylorus, however, the results are, I believe, as the doctor has mentioned, to say the least, uncertain.

Dr. EINHORN, New York City: I am very glad to be here to discuss Dr. Truesdale's very valuable paper. I saw his specimens and studied them a little while ago, and I certainly think that he deserves a great deal of credit for doing such important work.

My experience in this field has not afforded many opportunities to observe hypertrophy of the pylorus as a common cause of obstruction, for I have not made many sections of the pylorus. Usually the stricture, as it seems to me, is caused by scar-tissue or in some instances ulcers of the pylorus which precede muscular spasm. In the cases I have observed there was no apparent hypertrophy, but, as the reader said, this condition of hypertrophy develops if there is a considerable and continued spasm; and we would say in a year or so, such changes occur as a functional disturbance. Now, with regard to the atrophy, a similar condition may exist too, as he says, after gastro-enterostomy, as the result of a greater limitation of the normal action of the pylorus.

I would like to call attention to a class of cases in which there are two things present at the same time: a lack of motility and a lack of patency of the pylorus. The pylorus can neither close entirely nor can it open well, and this is found not only in malignant diseases, but in benign conditions as well. Fibrous tissue may interfere with the function of the pyloric muscle so that it cannot normally open and close. I have seen cases where a good operation had been done primarily, and have found that condition interfering with the success of the gastro-enterostomy.

With regard to the function of an organ going on in the presence of definite pathological changes, I have discussed this topic before, about eighteen years ago, especially with regard to the circulatory function of the stomach. I have tried to demonstrate that oftentimes the pathological changes are not the cause of the functional disturbance, but that the functional disturbance existing a long time may induce pathological changes; for example, pathological lesions which follow functional changes in the mucosa as a result of disturbances of the circulation. I have written upon this subject and I believe that it is the theory which attracts a great deal of attention. This observation was based upon a theory similar in principle to that which Dr. Truesdale has now demonstrated.

DIAGNOSIS OF INTRATHORACIC NEOPLASMS BY EXPLORATORY PUNCTURE [1]

BY HUGHES DAYTON, M.D., NEW YORK
Associate Attending Physician, New York Hospital
From the Second Medical Division of the New York Hospital and the Laboratory of Surgical Pathology, College of Physicians and Surgeons

THE following case is reported as demonstrating the diagnostic value of examination of the tiny fragment of tissue obtained by exploratory puncture with an aspirating needle of moderate size in cases of intrathoracic lesions of doubtful character, and as a plea for the utilization of by-products.

H. T., a musician, single, age 19, entered the New York Hospital on April 2, 1913, complaining of pain in the right side, and cough. His family history was negative for tuberculosis. He had had no previous pulmonary or other illness excepting gonorrhœa nine months before admission, followed by double inguinal adenitis six months later. Soon after this he began to have sharp pain in the right side, increased by deep breathing or coughing. The latter occurred in attacks every morning on arising, but was unproductive. There were no other symptoms. Over the right chest posteriorly from the spine of the scapula to the base were dullness increasing to flatness, diminished fremitus, breath and voice sounds, and voice and whisper of nasal quality, with a few subcrepitant râles. A needle inserted into the right chest yielded a syringeful of bloody fluid containing many small opaque particles which consisted of cells resembling epithelium. The physical examination showed nothing else of significance. Fluoroscopic examination on the following day showed a shadow extending from the spine of the right scapula to the diaphragm, the upper limit of this shadow having a convex outline. Within this area of shadow were two semitransparent areas. A radiogram by Dr. A. H. Busby was reported as showing pleurisy with effusion. There was a daily afternoon rise of temperature of 1° to 2° F. The rectal temperature only once touched 101°, usually reaching 100° to 100.6° in the afternoon for nine days, subsequently rarely exceeding 100°. The pulse ranged from 72 to 112, generally being about 88. Blood examination showed 6,140,000 red blood cells, with 90 per cent of hæmoglobin. Leucocytes numbered 10,500 on several examinations, but ranged from 7,500 to 18,000. The polymorphonuclear leucocytes ranged between 54 and 85 per cent, mononuclears between 16 and 26 per cent, basophiles from 0 to 2 per cent. The eosino-

[1] Read before the Section on Medicine, New York Academy of Medicine, March 26, 1915.

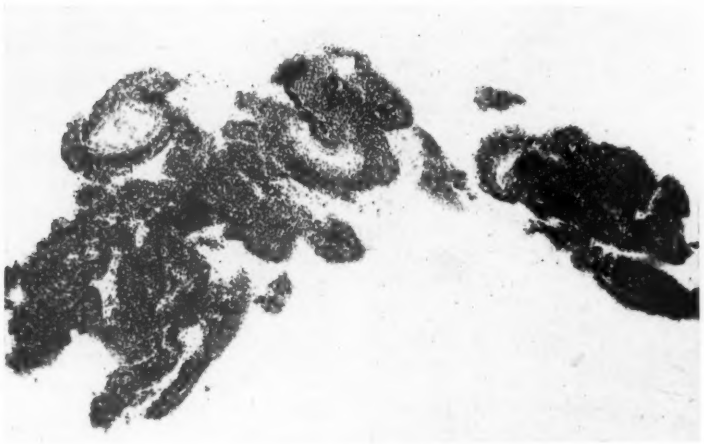


Fig. 1. Angiosarcoma of lung; diagnosis confirmed by specimen obtained with aspirating needle.

philes numbered 1 per cent, 11 per cent, 16 per cent, 7 per cent, and 7 per cent on successive examinations. The Wassermann reaction was negative. Seven stools were negative for blood, ova, and parasites. There was no sputum to be examined for tubercle bacilli.

On April 9, a loud friction rub was heard over the whole right chest anteriorly and the nasal quality of voice was confined to a small triangular area at the base of the right axilla. Three days later, slightly nasal voice was heard anteriorly from the level of the nipple down and in the seventh space posteriorly. A less marked friction rub than before was present over this region anteriorly. On April 14, the patient began to complain of pain in the right lumbar region which varied in intensity during the remaining two weeks in the hospital. On the 15th, examination showed the cardiac apex beat in the fifth space, 12.5 cm. to the left of the median line, and in the right chest tympany over an area 6 to 7 cm. wide to the right of the midsternal line. Over the rest of the right chest anteriorly, from the second rib down, was marked dullness increasing to flatness. Over both these areas was a loud friction rub, especially when recumbent. Posteriorly from the fourth rib down, signs were as on admission excepting that nasal voice was quite marked near the vertebral column from the eighth space down. There were tenderness of the right quadratus lumborum and prominence of the first and second lumbar vertebral spinous processes, but a radiogram of this region was negative. The patient lost six pounds in twenty-six days.

The convex upper level of the shadow in the chest and semitransparent areas within it; the blood-tinged chest fluid; the displacement of the heart toward the left; the presence of a tympanitic area between the area of cardiac dullness and that of dullness in the right chest anteriorly, with a friction rub over the area of dullness; the persistent eosinophilia in the absence of intestinal parasites or other obvious cause; and the irregularity of the areas of nasal voice—all suggested the existence of a neoplasm rather than a serofibrinous pleurisy. To substantiate this opinion a needle was inserted into the right chest in the ninth space near the angle of the scapula in order to obtain a fragment of tissue for examination. It encountered resistance from the start. This became greater within the chest, and then about 3 cm. of a blood-tinged serous fluid was obtained, which did not coagulate on standing and in which were two small fragments which resembled thick mucus enclosing shreds of tissue. The fluid showed chiefly lymphocytes with a few eosinophiles, polymorphonuclears, and basophiles. The fragments of tissue obtained were cut and stained at the laboratory of surgical pathology of the College of Physicians and Surgeons. The sections measured about 1 mm. in diameter and 1.5 mm. in length. They were examined by Dr. Wm. C. Clarke, who made the diagnosis of angiosarcoma.

On April 29, the patient was discharged from New York Hospital, and on May 3 he entered the German Hospital, through the courtesy of whose superintendent I am able to record the termination of the case. On May 28, the tumor was removed from the right chest, and death occurred the same day. The neoplasm is described as a "malignant cellular tumor composed of small round-cells closely packed together, with no definite stroma and with a minimum amount of finely granular intercellular substance. The blood-vessels are rather numerous and possess exceedingly thin walls. The tumor cells themselves surround these blood-vessels in

the form of a mantle. This perivascular arrangement is more noticeable in some fragments than in others and probably represents the proliferation of the tumor cells in the perivascular lymph spaces; otherwise there is no trace of the original pulmonary tissue."

Encouraged by the success in diagnosing this case, the writer has attempted the same unsuccessfully in two others. In one, the tumor was found at autopsy to be confined to the root of one lung, where puncture would have been dangerous, the rest of the lung showing pneumonic consolidation. In the other, no autopsy was obtained, but the diagnosis was confirmed by removal of a supraclavicular lymph-node which showed infiltration of the surrounding tissue with cells resembling those of so-called "endothelioma" of the pleura. In this case the fragments obtained by puncture consisted of fibrinous exudate containing lymphocytes with a single group of large, unevenly staining cells which resembled mesothelium.

Examination of fragments of tissue obtained by exploratory puncture, employing a needle with a lumen of about 1 mm., is of diagnostic value only when the results are positive; but in these instances it may be of real assistance in differentiating from syphilis, tuberculosis, and delayed resolution of pneumonia. The dangers of exploratory puncture are those associated with perforation of a solid or chronically inflamed lung, the most serious of which are hæmorrhage and cardiac or respiratory failure, convulsions, coma, or transient paralysis from pleural reflex;[1] but these are sufficiently rare to be disregarded when diagnostic information is needed. Puncture near root of lung should be avoided, as these accidents are most common when this portion of lung is wounded.

[1] Dayton, H. Surg., Gynec. & Obst., 1911, xiii, 607.

OSTEOMYELITIS OF THE LOWER JAW

Its Proper Treatment, Including Bone Grafting, Showing the Necessity of Associating the Dental Surgeon with the General Surgeon[2]

By HENRY SAGE DUNNING, B.S., M.D., D.D.S., CLARENCE A. McWILLIAMS, A.M., M.D., F.A.C.S., and V. E. MITCHELL, D.D.S., New York

BY H. S. DUNNING, B.S., M.D., D.D.S.

OSTEOMYELITIS, osteitis, and necrosis of the inferior maxilla occur very frequently in spite of the wonderful blood supply of this part. We see a great many cases of necrosis of the inferior maxilla at oral surgery and dental clinics of this city, and many of these cases result in loss of the teeth and portions of the maxilla, and sometimes terminate in marked facial deformity. The alveolar processes of the maxillæ become infected and necrosed more often than any other bones in the body, on account of their thin covering of gum tissue, and because they lodge and are in direct communication with thirty-two teeth that are subject to infection at any time.

Infected teeth are insidious "volcanoes" that need very little to start them off into active eruption. Very few mouths of adults contain teeth that are not infected or have not been infected, and many mouths of persons over 35 years of age contain teeth that are abscessed or were abscessed at one time. Many devitalized, infected teeth are dormant for years and do not cause the patient any noticeable inconvenience, and the attendant necrotic condition is only discovered by radiograph examination.

The inferior maxilla readily absorbs infection from the teeth on account of its spongy, alveolar process, also on account of its position under the infected teeth. The infection naturally drains downward toward the bone into the inferior dental canal, and this is one reason why the inferior maxilla becomes infected more often than the superior

[2] Read at a meeting of the New York Academy of Medicine, April 2, 1915.

Fig. 1. Showing marked facial deformity resulting from chronic osteomyelitis of the inferior maxilla. Many operations were performed covering a period of ten years. The deformity was caused by infection of the temporary molars when a young boy.

maxilla, where the teeth drain downward away from the bone.

Necrosis is generally a self-limited process, but we find cases where one-half, three-quarters, or the entire inferior maxilla becomes necrotic, subsequent to the infection of one tooth. This is especially true of children, and we have many cases where the destruction of the inferior maxilla has been great, even though the abscessed teeth have been removed early and every means of drainage has been resorted to. These large areas of necrosis of the inferior maxilla are due to the infection from the teeth getting into the inferior dental canal and blocking off the inferior dental artery, which is the chief arterial supply to this part. An infected thrombus or actual destruction of the artery will cause a lowered vitality of the bone, and necrosis of the region supplied by the artery will follow. Thus we may have an abscess starting in the wisdom tooth and under pressure the infection enters the dental canal at this point and occludes the artery. If the pressure is not relieved the infection travels along the canal and in a short time the teeth anterior to the original abscess become devitalized and loosened and necrosis of the bone follows. Bacteriological examination in these cases generally shows a streptococcus infection which may or may not be accompanied by systemic symptoms.

Fig. 2. Shows a young man 20 years old, married. Wassermann negative. About four months before pictures were taken had toothache, lower first molar. The tooth was treated and became abscessed. The abscess seemed to spread to other teeth. It was opened very liberally outside of face, by a surgeon. Three large incisions were made. The condition did not clear up and every tooth in the young patient was extracted. The bone was then vigorously curetted and most of the jaw removed.

Fig. 3. Shows radiograph of operations of curettage of inferior maxilla and loss of entire mandible.

Fig. 4.

Fig. 5.

Fig. 4. Pathological fracture. No history of trauma. Chronic osteomyelitis for months. Fracture occurred by biting upon piece of crust.

Fig. 5. Shows radiograph of inferior maxilla. Severe osteomyelitis caused by infection of lower left first molar. Healthy young boy of 17. Tooth treated by dentist and later an abscess formed which was incised. Infection had entered inferior dental canal and had probably destroyed the inferior dental artery. Necrosis of one-half of the mandible and loss of all teeth resulted.

Infected teeth have been overlooked by the surgeon for years, and the so-called "gum boil"— which term ought not to be used — has often meant no more than a "cold in the head." The dentist is also responsible for necrosis of the maxilla by his passion for saving teeth — often ones that are badly diseased. Septic dental surgery produces many cases of osteomyelitis of the maxillæ, where the mechanical side of the dental surgeon's work appeals to him more than does the pathological problems before him. The surgeon in treating these conditions ought to be able to diagnose pulpitis and pericementitis, and ought to be able to recognize vital teeth from devitalized teeth. Teeth that are badly broken down and abscessed ought to be extracted at once before they cause abscesses and consecutive necrosis. How often do we hear patients say, "My dentist would not extract the tooth until the swelling went down"! Does the surgeon delay in operating upon the gangrenous appendix, and does he think twice in incising the tissues and tapping the long bones, in order to obtain drainage in true osteomyelitis? Drainage should be established before the pus is really under tension.

Fig. 6. Ramus of mandible removed from child of 6 years. Chronic osteomyelitis. It took about six months for the sequestrum to form, when it was "picked" out by the writer, leaving the periosteum. About a year later the patient was seen and one could hardly tell that the ramus had been lost.

The tooth that is infected is generally somewhat loosened in the alveolus, owing to the infiltration of pus into the peridental membrane, and it is painful to percussion in the acute stage. If, however, the abscess sac has ruptured and the pus has found its way through the alveolar process into the gum

Fig. 7.

Fig. 7. Shows a large area of necrosis extending from ramus to the bicuspid teeth. History of chronic osteomyelitis caused by infected teeth. There were several sinuses which drained into the mouth, but no sinus pointing toward face. The large black area is bismuth paste, pumped into the sinus in order to obtain a clear outline of the infected area in the radiographic examination. Cavity was gently curetted, and periosteum was preserved and bony cavity filled in after several months' treatment.

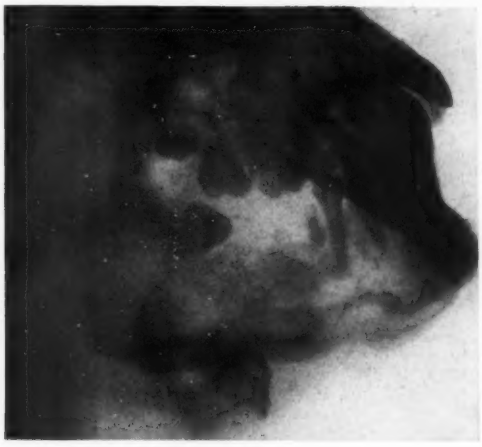


Fig. 8.

Fig. 8. Radiograph showing quite an area of diseased bone although the process had been quite recent. The inferior dental canal has been invaded, the artery has become involved, and the loss of all the teeth on this side resulted.

tissue the pain symptom may be lacking, but a radiograph will make the diagnosis. If the infection has had time to invade the bone the abscess will not be aborted by the extraction of the tooth. In these advanced cases one cannot always make the abscess drain up hill through the tooth alveolus into the mouth, but a good free incision should be made along the alveolar process directly over the apex of the infected tooth. If free drainage is not obtained then an incision should be made under the inferior maxilla at the point of fluctuation, parallel with the inferior border of the maxilla. Poultices, salves, and other hot applications that are so often applied are the causes of scars upon the face that might have been avoided. Early extraction and free incision inside the mouth generally control the acute condition.

I have not gone into the other causes of necrosis of the inferior maxilla such as fractures, systemic diseases, arsenic and phosphorus.

The treatment of chronic cases of osteomyelitis of the inferior maxilla should consist chiefly in establishing and maintaining good

Fig. 9. Young girl, age 12, chronic osteomyelitis. The picture shows large sequestrum that is merely held in place by soft tissues, the result of abscessed teeth. It took about four months for this necrotic piece of bone to become separated from its periosteum and to be exfoliated.

Fig. 10. Radiograph showing large area of bone lost in severe osteomyelitis covering about six months. The inferior dental canal has been split open by the infective process and its contents destroyed. Two devitalized teeth are projecting into the diseased area. Their blood supply and nerve supply have been cut off by the destruction of the inferior dental artery and nerve.

Fig. 11. Radiograph showing necrosis involving the alveolar attachment of the molar teeth. Under the first molar can be seen a large piece of necrotic bone which seems to be separated from the rest of the bone by infection. The vitality of both teeth has been destroyed and both were removed when the necrotic area was curetted.

drainage, and in free irrigation of this part. Sinuses should be kept opened with iodoform gauze and should be probed frequently to ascertain whether or not necrosed spiculæ of bone are being thrown off. The surgeon should of course help nature in this process of exfoliation, but he should be very careful indeed not to use the curette too vigorously. It is exceedingly easy for him to increase the area of necrosis by traumatizing the delicate new bone-cells that are forming in the osteogenetic layer. Nature herself must decide where to draw the line between the necrotic and the living, and it is the surgeon's work to remove the sequestrum when it is formed. This often necessitates incising the soft tissues and a gentle curettage of the infected bone.

Fig. 12. Shows profile of young child of six. Marked deformity present caused by loss of bone from chronic osteomyelitis covering a period of about six months. The inferior maxilla has been drawn backward by scar-tissue. No mechanical appliance was used to prevent deformity as the child's temporary teeth were not strong enough to attach splint to.

BY CLARENCE A. M'WILLIAMS, A.M., M.D., F.A.C.S.

The author has recently operated upon two cases of loss of the entire vertical diameter of the horizontal plate of the lower jaw, caused by osteomyelitis. In one the defect was so great that no union between the fragments had occurred, while in the second case union took place, after the loss of the bone, with resulting no-contact between the upper and lower teeth, so that chewing was impossible. In passing, the author is convinced that no surgical lesion is so badly treated generally as infection and osteomyelitis of the inferior

Fig. 13 (above). Radiograph of Case 1. See case for description.

Fig. 14 (above). Result of first operation, November 6, 1914, Case 1.

Fig. 15. Bone grafting, November 24, 1914, Case 1, showing interdental splint.

Fig. 16. After removal of the wires on the fiftieth day, Case 1.

maxilla. This poor treatment is due, first, to ignorance on the part of the general surgeon as to what the proper treatment should be, and, second, to insufficient association of the general surgeon with the dental surgeon. As to the proper treatment of early infection and necrosis, Dr. Dunning has given an outline of the proper treatment. My part of the program consists in describing measures which may be necessary to make up for a loss of bone sufficient to produce proper alignment of the teeth. If a fracture occurs in conjunction with active osteomyelitis and necrosis, the upper and lower teeth should be held

Fig. 17 (above). For description see Case 2.
Fig. 19. For description see Case 2.

Fig. 18 (above). For description see Case 2.
Fig. 20. For description see Case 2.

in their proper relations by wiring them together, or by some suitable apparatus such as Dr. Mitchell will describe. If there results a space between th efragments due to such wiring, then one may expect the filling in of a not too large defect by new bone, provided that the periosteum has not been destroyed by the infection, or provided that the periosteum has not been injured or removed by too vigorous operative treatment by the general surgeon. In rare instances, for example Case 1, Fig. 13, the defect may be too large to fill in, resulting in non-union, which may make the grafting of bone into the defect necessary. The customary and wrong treatment of these patients with necrosis is, first, in too vigorous operative zeal on the part of the surgeon with the

curette and chisel, thus injuring the periosteum; second, in not warning the patient against chewing upon hard objects in order to prevent a fracture taking place; and, third, in not providing the patients with suitable apparatus to prevent a fracture in cases in which the loss of bone has been very great with a consequent great weakening of the lower jaw. If a fracture occurs in association with active necrosis, as is frequently the case, or, if the total vertical diameter of the bone necroses away, the fragments are ordinarily allowed to fall together with a resulting deformity, depending on the amount of bone which necroses away. If the amount of bone be small, then the alignment of the teeth may not be seriously disturbed after union has taken place. If, however, the amount of bone lost be considerable, then the disturbance in the alignment or occlusion of the teeth after consolidation has taken place may be so great as to absolutely prevent chewing, as occurred in Case 2. This malacclusion should not be allowed to occur as it is easily prevented by wiring or apparatus.

With proper treatment of the original infection and subsequent necrosis, bone grafting would be practically never necessary. When it seems advisable to bone graft, several requisites must be observed:

First, the proper alignment of the upper and lower teeth must be maintained by suitable means, in my experience the best being the wiring of the upper to the lower teeth.

Second, no bone grafting should be done until all the sinuses are perfectly healed, so that no infection remains in the tissues.

Third, all the operative work of grafting must be done from the outside and the mucous membrane of the mouth must not be opened. This is to prevent infection of the graft. If, in making a furrow to lodge the graft and also while freshening the fragments, the mucous membrane of the mouth be accidentally opened, then at that time one should not insert the graft as it would most certainly be infected and die subsequently. The upper and lower teeth should be held in their proper relations, thus preserving the defect intact. The infected wound should

Fig. 21. Rib grafted into defect in the lower jaw.

be allowed to heal before the graft is inserted. In my experience, if the graft is infected from the mouth at the very beginning before the circulation has been established in the graft, it will certainly mean the death of the whole graft. This is not necessarily true of a more or less sluggish infection which comes on late about a wire suture. In such instances of late infection, there may be necrosis of a small portion of the graft, but it need not necessarily entirely die, if it has a good blood supply.

Fourth, the graft should always have periosteum on it and it should be taken from the patient himself who is to be grafted, preferably from the tibia. The crest should never be taken as a graft, as this so materially weakens the bone that a fracture of the tibia is liable to occur subsequently.

Fifth, the graft should not be touched by the gloved hand at any stage of the operation. It should be handled entirely by sterile instruments.

Sixth, the general surgeon should have the help and advice of a skillful dental surgeon in these cases of osteomyelitis and necrosis of the inferior maxilla.

CASE 1. Woman, age 33, referred to me by Dr. Crain, of Rutland, Vermont, through Dr. Downes, of New York. Her chief complaint was inability

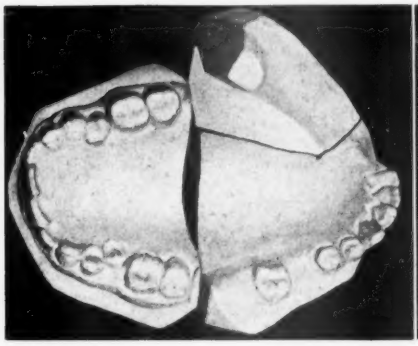


Fig. 22. Model for Case 2.

Fig. 23. Hard rubber splint on model.

to chew, due to displacement of the lower jaw. Two years ago she had had pneumonia. Four months afterwards two small hard lumps appeared on the under surface of the lower jaw. These were not painful until two months after their onset, when she had pain, like a toothache, and both lumps discharged, one on the inside and the other on the outside of the mouth. She went to a hospital where, during a curetting of the bone, the jaw was accidentally broken. For four months a plaster-of-Paris bandage was worn and during this time pieces of bone were discharged. Two of them were over an inch long. Bacteriological examination showed that the infecting organism was the pneumococcus. Nine months ago the larger right fragment of the lower jaw was wired to the upper to prevent its displacement inward and backward, so that chewing has been impossible. The sinuses have all been healed now for some months.

Physical examination is clearly made out in Figure 13. The horizontal portion of the left lower jaw ends in a triangular point, ABC. B is the beginning of the posterior border of the vertical portion of the bone, which has been pulled up anteriorly and held immovable in place by adhesions. The right half of the bone ceased at the left canine tooth, making the defect about an inch to be filled in. The right half was held in place with regard to the upper jaw by wires, so that this was in perfect alignment with the upper teeth. The first operation was undertaken on November 6, 1914. An incision was made in the line of the lower jaw on the outside along the line AB (Fig. 13), great care being exercised to prevent going through the mucous membrane into the mouth. The tissues were very adherent to the bone and they were stripped from the bone with the elevator. The triangular tip, ABC, was removed (Fig. 13). The next procedure was to mobilize the posterior fragment and to push it posteriorly, as it was fixed anteriorly. This was only accomplished after the entire surrounding tissues were stripped from the bone by the elevator on its outer and inner sides extending up as high as the condyle. I feared for the future blood supply of the bone, but this anxiety was subsequently proved to be needless. The motion even with this extensive separation was not yet free enough, so the coronoid process was divided at its base with a chisel. The motions of the fragment were then perfectly free, showing that the temperomaxillary articulation was uninvolved. The fragment was then sewed in its proper posterior position with chromic gut (Fig. 14) and the skin was closed without drainage. Healing was by primary union. The wires holding the teeth of the upper jaw to those of the lower right fragment were removed at the time of this operation.

The question of the best method of holding the fragments was placed in the hands of Dr. Dunning and Dr. V. E. Mitchell, who made an interdental splint (Fig. 15), which held both fragments in their proper relations. Eighteen days after the previous operation, bone grafting, on November 24, was done to fill up the defect (Fig. 15). Great care was taken in making a furrow to lodge the graft that the mouth was not opened. The fingers of an assistant in the mouth was a great help in preventing the opening of the mucous membrane. A graft from the tibia of the requisite length was taken with its periosteum by means of a motor saw. The ends of the fragments of the lower jaw were freshened with the chisel and each was drilled, as well as both ends of the graft. The graft was forced into place between the ends of the fragments and aluminum bronze wires were inserted and twisted and the ends cut off. Wires were used because it was feared that the strain on catgut would be too great. The skin was closed with silk without drainage. A bandage was placed about the lower jaw so as to hold it immovable against the interdental splint and the upper jaw. No part of the wound or the graft was touched by the hands.

A week after the operation a little serous discharge appeared in the front part of the incision and this in a few days became purulent. There was never at any time any temperature. The discharge never amounted to more than three or four drops,

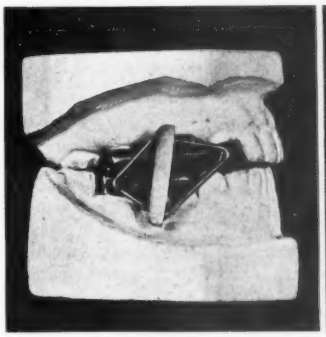


Fig 25.

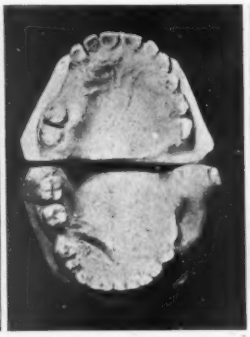


Fig. 24.

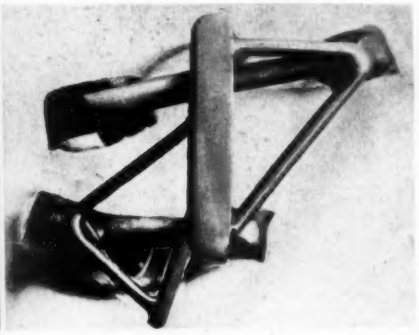


Fig. 26.

Fig. 25. Models showing appliance in position occluded. Fig. 26. Models showing appliance in position opened.
Fig. 24. Models of the mouth showing necrosed area.

but it was persistent. On the fiftieth day after the operation, using novocaine locally, I removed both wires. The anterior wire was the only one infected but for the sake of safety I removed both, since they had done their work by this time. The graft looked smooth and pink and seemed to be perfectly alive, and was fast in its position. The posterior wire was imbedded tightly in connective-tissue and there was no fluid exudate about it. The anterior wire on the contrary was surrounded by granulation tissue and there was some purulent exudate about it and in the meshes of the granulation tissue. Were I to do this same case over again, notwithstanding the infection, I should use wire again rather than catgut, since there was so much pressure on the graft, which had been wedged in, that it would tend to displace the graft. The slight amount of infection I do not think will injure the life of the graft. The wires remained in place long enough to accomplish their purpose: to hold the graft in its proper place until it should become fast.

An interdental splint was chosen rather than fixing the right larger fragment against the upper teeth with wires, because it was deemed best to form the interdental splint so that it would exert a pressure upon the smaller left fragment, to force it backward. Since the anterior end of the posterior fragment was free, there was a constant tendency for it to be drawn forward by the action of the muscles. It was hoped that the pressure of the splint on the soft parts overlying the fragment in the mouth would overcome this tendency.

A röntgenogram (Fig. 16) immediately after the wires were removed (50 days after the grafting), shows that the graft is larger than the original

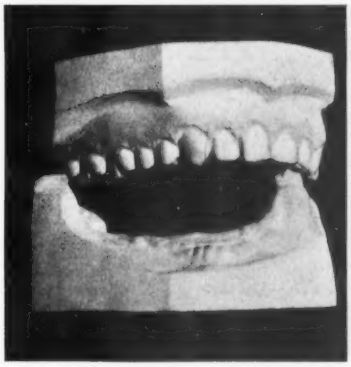
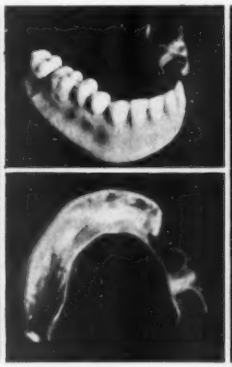


Fig. 27.



Figs. 29 (above) and 30.

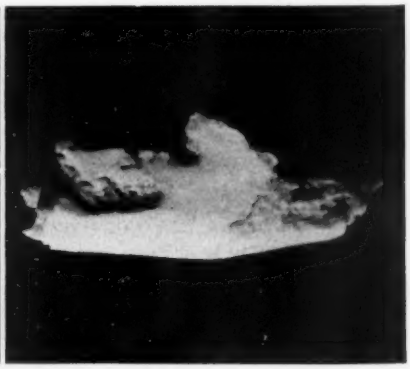


Fig. 28.

Fig. 27. Models of a mouth showing results of necrosis of lower jaw.
Fig. 28. Section of bone removed (sequestrum).
Fig. 29. Appliance constructed for this case.
Fig. 30. Same as Figure 29.

Fig. 31. Patient showing deformity.

Fig. 32. Patient with appliance in position.

graft, due to the proliferation of the periosteum, which was cut purposely, at the time the graft was taken from the tibia, larger than the bone section itself. When one wishes a graft to increase in size it is advisable that the periosteum be as voluminous as possible. Experience has shown, however, that when this patient begins to use her jaw in chewing nature will respond to the extra strain on the living graft by causing it to grow to a size necessary to sustain all force put upon it. During this period of increasing growth, care must be taken that the force shall be gradually increased and that no sudden great strain be put on the jaw in order that the graft be not fractured.

On March 29, 157 days after the grafting, the interdental splint was removed, and, much to our surprise and delight, there was found to be great freedom in the motions of the lower jaw, which indicates that a reunion had not occurred in the divided coronoid process. The graft was solidly inbedded in its place. There was no diminution in its size. There was, however, a small sinus directly in the center of the graft which exuded a few drops of pus due possibly to a small scale of bone or a fragment of wire.

Case 2. Woman, age 40, admitted to the Presbyterian Hospital, February 1, 1915; referred to me by Dr. Dunning from the Dental College. One year ago, the patient had an alveolar abscess with osteomyelitis of the lower jaw, resulting in fracture and necrosis. Dead bone was removed in one of our large hospitals. No attempt was made there to hold the jaw fragments in proper alignment. Consolidation in the position indicated in Figure 17, with great loss of bone of the inferior maxilla. The patient complained that she could not chew solids and was restricted to fluids. The motions of the lower jaw were normal in extent. On closure of the lower jaw it was seen that the lower teeth did not come within almost an inch of touching the upper teeth, being posterior as seen in Figure 18. A röntgenogram (Fig. 17) showed that both the horizontal and vertical plates, as compared to the normal side of the jaw, had disappeared to a very large extent. The vertical diameter of the horizontal plate on the affected side measures one-quarter of an inch, whereas on the normal side it measures two inches. The proposition presented was to fracture the horizontal plate, to separate the fragments until the teeth were in proper alignment and to insert a bone graft to fill up the defect. The first thing done was to have an interdental splint made which should hold the teeth after they were placed in their proper position. This was very kindly made by Drs. Dunning and Mitchell, and was ready to be inserted after the operation was performed. On February 4, 1915, the bone grafting was done under intrapharyngeal ether anæsthesia. Transverse incision was made along the position of the normal lower jaw. This was carried upward to the under surface of the horizontal ramus. The soft parts were carefully separated from the ramus, while an assistant held his finger in the patient's mouth, this being a great help in preventing the accidental opening of the mucous membrane. Practically the whole ramus was separated and the mucous membrane was thought not to have been opened. The ramus was vertically divided with bone-cutting forceps and, using considerable but gradual force, the fragments were separated about an inch by means of a two-bladed forceps which was opened by a screw. The interdental splint was then inserted in the mouth by Dr. Dunning and this maintained the defect. Some of the horizontal ramus was removed because of its thinness. The defect to be filled in measured just an inch. Using a circular motor saw, an inch piece of the lateral aspect of the tibia was removed with its periosteum cut larger than the bone section, which latter opened the medullary cavity. Both ends of the graft as well as both ends of the fragments were drilled. In the anterior holes a silver-wire suture was passed and twisted, Fig. 19. In the posterior holes a large sized kangaroo-tendon suture was passed and tied. Perfect alignment of the teeth was secured. Three days after the operation a röntgenogram (Fig. 19) showed that the graft at its posterior insertion had become displaced, owing to the stretching of the kangaroo tendon. Therefore on the seventh day I reopened the clean wound and wired the fragment.

There was no temperature post-operatively but on the tenth day there was a slight discharge from the back part of the wound, and on taking out the stitches there was a discharge of material from the mouth showing that a communication had taken place between the mouth and the graft. On the twenty-first day the dead bone graft was removed, the interdental splint being left in position to hold the defect open and retain the teeth in alignment.

Note. — On May 18, 1915, I regrafted the entirely healed lower jaw of this patient, using a graft with periosteum from the tibia and fastening it in place with chromic gut. Perfect primary union resulted.

Case 3 (Fig. 21), is added to show the value of the periosteum on a graft. In 55 per cent of my experiments on bone grafting, if the transplant was without the periosteum the graft disappeared. In the following case it was entirely gone in five months.

CASE 3. In November, 1910, I removed half the lower jaw from a lad of 12 for a large giant-cell sarcoma. Fifteen months later I grafted into the defect in the lower jaw a piece of rib which was entirely stripped of its periosteum. One end of the rib was beveled and this was sutured to the freshened edge of the remaining half of the jaw. The wound healed by primary union. Figure 21 shows the rib in position. Five months later, a röntgenogram showed an entire disappearance of the grafted rib. There never was any discharge from the scar

PROSTHETIC APPLIANCES

BY V. E. MITCHELL, D.D.S.

The many deformities resulting from necrosis of the lower jaw are in most cases preventable, when proper mechanical means are employed, at the proper time.

When a portion of the jaw is lost, either through necrosis or by removal surgically, the remaining fragments or parts are drawn toward each other by the contraction of the muscles, and the teeth are thrown out of occlusion (malocclusion), producing in many cases a great deformity. To prevent this it is necessary to keep the remaining portions of the jaw immobile and in proper alignment by a fixation of the teeth in their normal occlusion. The simplest method is by ligating the teeth of both jaws together with bronze wires.

Angle's gold or German silver fracture bands, fitted to the teeth, with loops on buccal surfaces, which are drawn together with wire ligatures, are very satisfactory in some cases. Interdental splints of hard rubber or metal, cemented to the teeth (when teeth are present) are useful and specially indicated in other cases.

Figure 22 shows the models of the mouth of the second patient, reported above. Figure 23 shows the hard rubber splint on the models that was used in this case. A similar interdental splint was used in the first case and proved very satisfactory, but the second case did not, owing to lack of coöperation on the part of the patient. In that case I am sure a fixation of the jaws on the good side, by means of bands and wire ligatures, would have given better results. The mandible was severed and the jaw drawn over and forced into the splint before the graft was made. In the first case the splint was worn for five months. In necrosis of the mandible, from whatever cause, when the necrosed portion has been removed or exfoliated and when that portion of the healthy bone which remains is of insufficient strength to withstand the great force of mastication, spontaneous fracture is liable to occur.

To prevent such a condition arising, we should take precautions, and before operating prepare a mechanical device that when inserted will remove most of the strain from the weakened portion of the jaw. The lateral strain being the greatest, it is possible in many cases, while immobilizing the jaw still to allow the one movement, directly up and down; the freedom of the jaw will be of great benefit and comfort to the patient. To show the construction of such an appliance let me describe a case in practice. The idea comes from Germany. An appliance of similar nature was first constructed by Dr. Rosenthal.

Miss P. age 28, necrosis of mandible on left side, extending from first bicuspid back to the ramus. X-ray showed a considerable area of necrosis, which after removal would leave a weakened condition of the mandible. It was decided to immobilize the mandible in all directions except directly up and down. To allow this a sliding foot and shoe apparatus was made in this way: gold and platinum bands, thirty-two gauge, were made to fit perfectly the right upper cuspid and first molar, and the lower second bicuspid and second molar. These were joined together on their buccal surface by a heavy clasp metal bar and an eighteen gauge wire on their palatal and lingual surfaces. To the upper bar was soldered the shoe, a three-sided box in which the foot, a slightly curved bar, would slide when the mouth was opened. The shoe was attached to the upper jaw. The lower jaw could not move forward, nor, from the nature of the appliance, could the jaw be moved laterally.

This appliance was cemented to the teeth a day before the operation. It did not interfere with the work of the surgeon, and was allowed to remain in position for six weeks.

CLINICAL ASPECT OF DISEASE OF THE EXTRAPERITONEAL APPENDIX VERMIFORMIS

With Report of Cases[1]

By ABRAHAM STRAUSS, M.D., Cleveland, Ohio

THE extraperitoneal appendix though not common is not uncommon. Its occurrence has been explained on embryological grounds by the development of the appendix in the left half of the abdomen and its journey to the right iliac fossa (1). Embryologists are agreed that the development is essentially as follows: The primary intestinal loop is straight and just to the left of the midline in the embryo. About the fifth week the small and large intestine become differentiated, as is shown by a swelling in the primary tube. This enlargement becomes the cæcum, and soon can be seen a diverticulum from this, which forms the appendix. Then begins the rotation of the cæcum and colon from left to right. The cæcum crosses at the fourth month and lies immediately below the liver and descends to the right iliac fossa near the end of fœtal life. During all this time the mesenteriolum, as well as other folds of peritoneum, are being formed and turned. Thus it may be readily seen that in transit the appendix has many chances to become fastened to the posterior abdominal wall and have the peritoneum spread over it instead of enveloping it and forming a mesentery. Craig (2) mentions four factors which may influence the position of the appendix:

1. The place at which the cæcum stops.
2. The relative dilatation of one or more of the walls of the primitive caput coli.
3. The resistance the peritoneum offers to its descent.
4. The mobility of the parts as influenced by reflections of peritoneum about the ascending colon forming in some cases a very wide mesocolon and in others none.

The last two, of course, bear on the subject, as will be seen from Briggs' classification below.

Briggs (3) names six types of extraperitoneal appendix, classifying them, according to their relation to the posterior surface of cæcum and ascending colon, as follows:

1. Those lying against the posterior wall of the cæcum with no mesentery.
2. Those in which the proximal portion only is extraperitoneal, the distal portion being free. Holmes (4) reports such a case.
3. Those in which the proximal part lies against the cæcum and the rest lies behind the large gut extraperitoneally (Huntington, 5).
4. Those in which the appendix and posterior surface of cæcum are extraperitoneal (Thompson, 1).
5. Like 4, with tip of appendix projecting.
6. Those in which the tip is extraperitoneal behind the cæcal wall, the rest being invested by peritoneum.

Wheeler (6) reports an instructive case that may be classed under type 4. His case was that of a cadaver having an appendix six inches long lying to the outer side of the posterior wall of the ascending colon and extraperitoneal. At the end was a long fibrous cord continuous with the peritoneum over the front surface of the kidney. His explanation for this position was that a low grade peritonitis had occurred in intrauterine life during the descent of the cæcum and had anchored the tip of the appendix in inflammatory material.

In 200 dissections Ferguson (7) found 77 cases in which the "appendix was so placed and covered by peritoneum that its perforation would open into subperitoneal tissue. . . . In these cases pus would most likely finally present itself in the situation of a psoas abscess."

Turner (8) reported a study of 105 cases post-mortem which showed the appendix twice completely and four times partially extraperitoneal. He concluded that peri-

[1] From Mount Sinai Hospital, New York City.

typhlitis results from appendicitis, and that paratyphlitis results, not from perityphlitis, but from a retroperitoneal phlegmon of an extraperitoneal diseased appendix. This is contrary to Murphy's views (9); namely, that the "appendix is rarely found behind the peritoneum, although retroperitoneal abscesses are not rare, due to perforation and not to malposition of the appendix. Many times it is embedded in the wall of the caput coli posteriorly, a position always pathologic and never anatomic."

Bryant (10) reports 3 extraperitoneal appendices out of 144 cadavers examined. Stroud (11) found 9 out of 577 cases partially or wholly extraperitoneal. Albrecht (12) shows a picture of one, and says the only ones he found in 500 cases were those in which the peritoneum enveloping the appendix was spanned from one ridge to another. Liertz (13) mentions 2 from 300 cases. And Thompson (1) described a post-mortem at which he found the terminal portion of ileum, cæcum, and vermiform process each situated behind the peritoneum in the right iliac fossa. This was one of two cases found in examinations of 25 subjects.

Clinical reports, on the other hand, are not so numerous. Briggs (3) reported a case of a girl who had three attacks of appendicular colic. The tip of her appendix was retrocæcal and extraperitoneal.

Sprengel (14) states that he had one case at operation, and quotes Lennander as having met with an extraperitoneal appendix once at an interval operation and once at an operation for an acute attack. Moynihan (15) refers to it only as a possibility. Kelly (16) shows two beautiful pictures representing a case of Finney's and one of Follis'.

However, the clinical knowledge of appendicitis is not helped from such reports. Bryant (10) stated that "extraperitoneal appendicitis with symptoms of obscure suppuration had been mistaken after the escape of pus for psoas abscess, liver abscess, Pott's disease, malignant disease, and perinephritis." One of Ferguson's (7) cases was a man of forty who died of pneumonia and had had a discharging sinus mistaken for a psoas abscess. "The sinus was found to be ten inches long and led to a perforated extraperitoneal appendix, in reality a fæcal fistula."

The cases reported below fall under three heads:

1. Those presenting a straightforward picture of acute appendicitis (2 cases).
2. Those simulating a perinephric abscess (2 cases), as Bryant mentioned.
3. Persistent fæcal fistula (1 case), as Ferguson's case.

These five cases were operated upon by Dr. Edwin Beer, whom I wish to thank for the suggestion and permission to report them.

CASE 1. H. B., No. 586, male, age 50 years. Admitted to the hospital March 2, 1908; discharged March 29, 1908.

Past history, negative.

Present illness. Onset twelve days before admission with severe pain in the lower right quadrant of the abdomen, radiating to the hypogastrium, and lasted four days. During the four days just before admission had slight pain at the site of onset. There was no vomiting, fever, or chill. Bowels regular. No urinary disturbance. Temperature, 98.6° F.; on admission rose to 100.4°; pulse, 80; respiration, 24; urine, negative.

Physical examination. In the outer part of the right iliac fossa about three-quarters of an inch above and parallel to Poupart's ligament was a mass two and one-half inches long, the upper end level with a line from umbilicus to anterior superior spine. Mass firm, fixed, slightly tender.

Operation, March 3. Appendectomy and drainage for acute appendicitis, extraperitoneal. Kammerer incision. In lower part of right iliac fossa and adherent to iliac wall a hard mass was palpated through anterior cæcal wall. Cæcum adherent to posterior and lateral wall, freed and delivered into wound. No appendix could be seen. The above-mentioned mass was now felt on outer wall of cæcum and posteriorly. Peritoneum over it incised and appendix found coiled up on posterior cæcal wall. The tip was buried. Appendix removed retrograde. Tube drain, wound closed in layers. Recovery uneventful.

CASE 2. F. N., No. 150,379, female, single, age 20 years. Admitted to the hospital November 28, 1914; discharged December 19, 1914.

Past history. Scarlet fever and smallpox as a child.

Present illness. Onset six days before admission with general abdominal pains, which later became localized in the right lower quadrant. Pains persisted until the day before admission, when they became milder, and on that day she vomited twice. Temperature, 102° F.; pulse, 120; respiration, 24; urine, negative.

Physical examination. Rigidity and tenderness over right half of abdomen, most marked over McBurney's point.

Operation, November 28, 1914. Appendectomy and drainage for acute gangrenous appendicitis with abscess, wholly extraperitoneal. Kammerer incision. Caput coli could not be well drawn up. There was no evidence either of old or of recent intraperitoneal inflammation. No appendix could be seen. A coiled mass was felt to the outer side of and behind the cæcum. The peritoneum was cut transversely at the reflection from the cæcum. This allowed the cæcum to be drawn up into the wound and disclosed the appendix pointing upward with its tip surrounded by an abscess and fastened to iliac fascia over psoas muscle. Appendix removed and a drain inserted. Recovery uneventful.

These two cases are instructive because they illustrate what the operator must expect and look for before he gives up the search and reports a case of congenital absence of the appendix. Neither case had psoas spasm or any unusual sign which would lead one to expect an abnormally placed appendix.

CASE 3. L. C., No. 136,025, male, single, age 24 years. Admitted February 1, 1913; died July 6, 1913.

Past history. Six months before admission had four attacks of gastro-intestinal disturbances and was told he had a gastric ulcer. He was subsequently treated in a Chicago hospital for disease of the right kidney.

Present illness. Onset six weeks ago with pain in right iliac region, radiated to the left side of the abdomen. No vomiting, chill, or fever. Lost twelve pounds. Bowels constipated.

Physical examination. Patient was pale, thin, and looked sick. In right hypochondrium there was a marked resistance and a ballotable mass that moved with respiration. There was quite some tenderness in the right lumbar region. There were signs of mitral stenosis and insufficiency. Temperature 100.8° to 102.6° F.; pulse, 86; respiration, 24.

Operation, February 3. Expecting to drain a perinephric abscess, due in all probability to a diseased appendix, the incision was made over the tender point in the lumbar region. This opened an extraperitoneal abscess in which lay the appendix. This was removed without entering the peritoneal cavity and the wound drained. Actinomycetes were found in the pus.

Repeated urine examinations showed acid reaction and a very faint trace of albumin, occasional hyaline casts, and a few leucocytes; no bile.

March 24: Temperature was greatly remittent. Rigidity and tenderness noted in the right hypochondrium. May 21: Incision and drainage of abdominal abscess through an upper right rectus incision. This abscess was considered extraperitoneal by extension and subhepatic. The patient gradually grew weaker and died July 6.

CASE 4. A. F., No. 1,480 X, male, married, age 34. Admitted July 21, 1910; discharged August 31, 1910.

Past history. "Nephritis" six years before admission. Typhoid four years before admission.

Present illness. Onset four weeks before admission with pain across the abdomen, localizing two days later in the right lower quadrant, where it remained two days, after which the patient was free of pain for one week. Ten days before admission he was again seized with a sharp, constant pain which did not radiate and which he located in the right loin. Six days later he had a similar attack.

Physical examination. There was distinct bulging in the right posterior lumbar region with slight redness of the skin and distinct tenderness. A mass could be felt bimanually.

Temperature, 104° F.; pulse, 112; respiration, 48. Urine showed acid, albumin, granular casts, and pus-cells. Blood count showed 20,000 leucocytes, 90 per cent polymorphonuclears. Cystoscopy negative. On July 23 temperature 100° F.; pulse, 108; respiration, 24.

Operation by Dr. Lewisohn consisted of incision and drainage for right perinephric abscess. Large abscess filled with foul-smelling pus opened. It was noted that the cavity ran down "toward the appendix region." Kidney was apparently normal. Tube inserted. Four days later a fæcal discharge was noticed. July 31: Counter-incision in right inguinal region for drainage. August 31: Wound almost closed. Referred to the dispensary for dressings.

On October 27, 1910, the patient was readmitted to the hospital, No. 562 IV. Since leaving the hospital he had felt well until two weeks ago, when both sinuses closed. Fever and slight pain in the right iliac fossa followed.

Operation, October 31, by Dr. Beer. McBurney incision. Cæcum was firmly bound to posterior abdominal wall. Following the striæ and after incising the parietal peritoneum adjacent to cæcal wall the operator found the appendix, extraperitoneal, behind the colon, and adherent in the sinus from the former operation. Appendix removed. Wound drained. A fæcal fistula followed, which closed slowly, and patient was discharged well on February 1, 1911.

These cases are examples of the type of appendix that forms an abscess which extends upward and that lies near the kidney, thus presenting the picture of a perinephric abscess. Case 3 also had an extension toward the liver. Lejars (17) mentions a case of prerenal abscess which extended upward to the under surface of the liver, and adds that an abscess may become subphrenic or intrahepatic. He also states that he had two cases of perinephric abscess of appendiceal

origin recognized by the fetid pus. In Case 4 the history was typical of recurrent attacks of appendicitis, and, although the abscess pointed in an unusual place, when such pus is found, and especially when the cavity leads to the site of the appendix, one must not forget the extraperitoneal appendix as the etiological factor. This case also has bearing on the class to follow because it had a persistent fæcal fistula, which is another sign to remember after incising an abscess in the lumbar region.

CASE 5. D. McC., No. 119,133, male, age 38. Admitted November 27, 1910; discharged March 12, 1911.

Past history. A year and a half before admission Dr. Beer had operated upon the patient at White Plains for appendicitis. He encountered an abscess and could find no trace of the appendix. Considering it had sloughed away he drained and closed the wound. The patient was discharged from the hospital seven weeks later with a fæcal fistula.

Present illness. He entered the hospital because of the sinus and because for the past three weeks he had *pollakiuria* and pain at the end of micturition. Urine was cloudy. Patient had fever during the last week. Temperature, 99.4° F.; pulse, 80; respiration, 20.

Physical examination was negative except for the scar and very small sinus. There was no discharge. X-ray examination with bismuth in sinus showed only that the sinus ran to the crest of the ilium.

December 4: Temperature rose to 102° F. Urine contained pus and albumin.

Operation, December 7. Old scar excised. Peritoneal cavity opened. Cæcum was adherent to anterior and lateral walls. While liberating it the cæcum was opened and the hole sutured. No appendix was visible. Then the sinus was traced. It divided, one branch leading down toward the bladder, the other leading up and behind the ascending colon. The parietal peritoneum along the outer border of the ascending colon was incised, the colon turned toward the median line, thus exposing the appendix, which was amputated. The appendix was perforated at the base. Wound closed with drainage.

This case emphasizes how careful one must be in the search for the appendix before being willing to say it is not there. Like Case 4 and the case of Ferguson, it shows that an extraperitoneal appendix left behind after draining an abscess will form a fæcal fistula. And finally, it teaches how difficult it is to cure such a fistula.

SUMMARY

1. Extraperitoneal position of the appendix is not uncommon.

2. The operator must be on the alert not to miss an extraperitoneal appendix and consider that it has sloughed away or that there was none.

3. Disease of an extraperitoneal appendix may give a straightforward picture of appendicitis.

4. Or it may simulate perinephric abscess or psoas abscess. It may cause a subhepatic abscess or a fæcal fistula.

5. Fetid pus obtained from an abscess incised in the right lumbar region should suggest to the operator a diseased extraperitoneal appendix as the etiological factor.

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THE RÔLE OF FAT DEPOSITION IN THE CURE OF ABDOMINAL PTOSIS, INTESTINAL STASIS, AND THE GENERAL ASTHENIC STATE[1]

By NOBLE WILEY JONES, M.D., Portland, Oregon

THE grouping of these three disease entities, to wit: abdominal ptosis, intestinal stasis, and the general asthenic state, is purposely made because the fundamental principles of treatment apply to each. These morbid states are essentially separate and distinct entities in themselves and may exist by themselves through the working of diverse causes, although they so frequently coexist that they have frequently been referred to as synonymous conditions. It is not as easy to define these terms as it is to state and to make use of them. Still, on the other hand, it is not so essential to give a strict scientific meaning to them as it is to give a clinical interpretation which from a practical or clinical standpoint holds true. It is from this viewpoint that the writer has defined these terms both here and in other papers.

Abdominal ptosis is considered a morbid state only when it produces symptoms itself, as in a midline stomach ptosis of marked degree, a true floating kidney, etc., or when it is associated, as is usual, with either or both an intestinal stasis and the general asthenic state. Intestinal stasis is likewise considered from a clinical standpoint only, and no regard is given to the particular toxic products of intestinal putrefaction or fermentation, or to the pathways by which they may affect the human body harmfully. The fact remains that a harmful effect is produced, because when the stasis is removed the effect disappears, and it returns again as soon as the intestinal stagnation returns. This is the interpretation which Lane has given to the term, and it is fundamentally true from a clinician's standpoint, notwithstanding the adverse criticisms which it has received from some pathologists and pathological chemists. This is the interpretation to which the writer, from a clinician's standpoint, has always held in the rather large experience with these cases, both from a surgical (in conjunction with Dr. Coffey's work) and from a medical point of view.

To define general asthenia or the general asthenic state is still more difficult, but again from a clinical standpoint it is to be separated from neurasthenia, with which it is generally confused. Asthenia means without strength, and in a medical sense was first used by Brown in 1780 as opposed to the sthenic state. It has undergone several changes in its significance since then, until the common acceptance of its meaning has been that of neurasthenia. General asthenia and neurasthenia are looked upon by most physicians today as being synonymous states, and have been treated quite generally along the principles laid down by Weir Mitchell and developed by his followers, especially DuBois, Déjerine, and Marie. But general asthenia is essentially a physical state; it has fundamentally nothing to do with disturbances of the psychic mind, which is the basis of neurasthenia. It is characterized by a general slowness of all mental and physical movements, the impossibility of all excesses; but on the other hand it is characterized by the ability of the individual to overcome by force of his will power this body weakness, of which he is at all times conscious. The clinical picture of the general asthenic is different from that of the neurasthenic. The patient has the attitude of listlessness and general body weakness. In marked contra-distinction to the ordinary neurasthenic, who relates with enthusiasm the manifold details of his illness, this patient states his history only by the aid of close questioning. He is psychically balanced and, also, when not too discouraged, will show a grim determination to override what he recognizes as the weakness of his body by force of will power. This attitude the neurasthenic never manifests. Let there enter into the above

[1] An address before the Spokane Medical Society, Spokane, Washington, December 1, 1914.

picture disturbances of a psychic nature and the patient will take on the traits of both conditions. This combination of the essentially physical with the essentially psychical, however, is on the other hand not so frequently met with as one would at first glance believe.

Let one stop here and ask what is the cause of the general asthenic state, and immediately one is engulfed in a maze of developmental and pathological facts and fancies, the true interpretations of which no one as yet knows. From our clinical experience we can safely say that the general asthenic state may be both acquired and in a sense congenital. Acquired in the adult by reason of a tuberculous infection, a pernicious anæmia, frequent childbearing. I have reported typical examples of the general asthenic state in adults of broad frame and without ptosis, the result of intestinal stasis due to right-sided pericolitis. In the latter cases the congenital factor did not enter at all and yet the general asthenic state of the individuals was as marked as ever seen in the congenitally ptotic type of Stillers.

The majority of general asthenics do belong to Stillers' asthenia universalis congenita, a type characterized by the slender, gracile, bony frame emphasized by Goldthwait, the straightened pelvic basin first described by Walkow and Delitzin and later by Coffey, and the congenital mesenteric malformations emphasized by Coffey and the writer in previous publications. But what underlies the development of the asthenic type on the one hand, and the asthenic state on the other? The asthenic type exists in healthy young children and may easily be recognized. Albu found ptosis in the newborn in 27 per cent of the female and 4 per cent of the male children; and in children below the age of puberty he found 44 per cent of ptosis in females and 11 per cent in males. Children usually do not develop the general asthenic state, however, until after puberty, when the body rapidly lengthens, and we may say also when chronic intestinal stasis most frequently makes its appearance. The asthenic type fundamentally is in all probability an inherited type of body structure passed on from parent to child. The inheritance of the acquired narrow waist, and the effect of the fashionable "gradual decline" into which the ladies of the time of Louis XIV entered so willingly, may be present today in their descendants. There is a racial as well as a family tendency to this body type. There is no doubt that the extreme ptotic type found in the British and French is not found frequently in the Germans; and this explains the general lack of interest and understanding of the subject among German physicians. Incidentally the work of Professor Rovsing of Copenhagen has done more in the past two years to emphasize the importance of this field of work on the Continent than that of any other, and it has done much to offset the antagonism to Lane's extreme views.

The development of the general asthenic state in the person of the general asthenic type of build, it has seemed to me, is to be explained most logically by reason of certain ill-defined morbid states produced as a result of the asthenic body formation, which morbid states assist, in the way of a vicious circle, in exaggerating the anatomical changes during the time when the child is developing into the adult. I say as a result of the body formation, and not coincidental with it, because the asthenically built child by proper physical training and attention to bowel function need never develop an asthenic state, although he must retain his general body build. He simply prevents the occurrence of those factors which lead to the asthenic state if allowed to develop. Again, if this is not true how can an individual with a well-developed general asthenia be cured of it and be taught how to prevent its return, if it is not simply an acquired state, the result of the congenital body build, and not an inherited character itself? Our experience has led us to believe that theoretically every case of general asthenia can be cured and be taught the principles upon which a lasting cure depends, and yet the type of body build is not fundamentally changed at all, it is simply in a measure remolded. Again, I do not believe that the asthenic state can be an inherited state, because in the non-asthenically built adult it can be reproduced typically in all of its

phases by a mechanically produced intestinal stasis, such as has resulted in our experience from a severe right-sided pericolitis, which, when relieved, has permitted again the complete relief of the general asthenia.

What the factors are that produce the general asthenic state and how they produce it is impossible for one to state. They may be wholly of the nature of chronic intoxications, as Lane has assumed; and this is borne out by the appearance of a severe asthenia from intestinal stasis in those individuals in whom ptoses do not exist, in chronic infectious diseases, in Addison's disease, pernicious anæmia, etc. It may depend possibly upon interference with the function of the ductless glands. For instance, it may be due to a disturbed balance between the sympathicotropic and the vagotropic functions of the adrenals operating through or upon the autonomic nervous system. In fact there is a striking resemblance between certain severe, pigmented, toxic types of intestinal stasis and Addison's disease, which is known to be associated with an atrophy of the adrenal glands. The mechanical traction upon blood-vessels and the nerve-filaments of the autonomic nervous system produced by prolapsed viscera in a subject largely devoid of intra-abdominal fat may have its influence in the production of the general asthenia, although this factor could not well operate in the individual who has no visceral prolapse.

Some four years ago my work with patients suffering with general asthenia and the effects of abdominal ptosis and stasis led me to correlate the diverse factors of their treatment into four fundamental principles. The close observation of my earlier cases and the experience gained with others since then has made me more and more convinced that these principles are truly fundamental. They are briefly as follows:

1. The absolute regulation of the bowel, i.e., the relief of stasis, by dietetic and postural methods alone. This includes the removal of all surgical barriers (for the most part irrelievable duodenal, ileal, or cæcal stasis which is mainly due to bands, extreme mobile cæcum, extreme midline ptosis, and extreme matting due to pericolitis). These surgical barriers are found in somewhat less than ten per cent of all patients seeking relief from their symptoms.

2. The deposition of extraperitoneal fat.

3. The remolding and physical development of the body. The expanding of the upper abdominal and lower chest cavities, and the correction of postural strains and faulty postures, are best carried out along the lines first systematically taught by Goldthwait. With these procedures well under way the patient must be carried through a long course of physical training which has for its object the gaining of general body tone. This part, when possible, should be supervised by a competent physical instructor and should be diligently persevered with over a period of months.

4. Fixation of body habit. The fixation of the body habit means simply the overcoming of the general asthenic state. It requires from one to two years of sufficient body weight, of normal bowel function, and systematic physical training to produce a permanent end-result. The patient must be educated in these various principles and be persuaded to carry them out to the end. It is necessary to appreciate the fact that there must be a perfect harmonizing of all of these principles in order to obtain an end-result. The failure to obtain any one principle will result in general failure. There are, however, only two factors which are really encountered that produce this failure; namely, the finding of a surgical barrier to the relief of stasis, which the patient does not choose to have relieved surgically, and, secondly, associated psychical disturbances that cannot be removed and which prevent control. It is important to emphasize in passing that the mere removal of a surgical barrier will seldom if ever bring about a cure; it is only one factor of a general plan; and it is the lack of understanding of this general plan on the part of many surgeons which has brought conservative surgical procedures for the relief of these barriers into undeserved disrepute. The removal of the barrier surgically merely places the patient in a condition where he can be cured medically.

Fig. 1.

Fig. 1a.

Figs. 1 and 1a. Illustrating the effect of fattening on the position and size of the stomach. Case of a young woman who gained thirty pounds in six weeks.

In the handling of asthenic ptotic patients by the above principles of treatment there are two very striking results observed clinically. The dilated atonic stomach is converted into a contracted tonic organ. There is frequently a six-hour rest in the former by reason of its prolapsed position and its weak peristaltic waves. Whether its position is altered or not by the fattening, the stomach becomes noticeably contracted in size, and deep, vigorous peristaltic waves empty it in normal manner. Overloading the dilated asthenic stomach with food never dilates it further, unless there is organic narrowing of the outlet; it restores its tonicity. This fact is fundamentally opposed to the teachings of all standard authorities on diseases of the stomach. Ewald, Boas, Zweig, Cohnheim, Bassler, Kemp, and others, all teach essentially the same principles; namely, small meals, frequently given, in the horizontal position. These principles are wrong. Feeding should be forced to the limit of endurance with a mixed diet of high calory content. The position is quite immaterial, although the training of a patient in the art of overfeeding is best started in bed where the attending distress may be relieved by heat, massage, etc. X-ray examinations made in series at intervals of a few days show that the tone and contraction of the stomach begins early in the course of forced feeding, before there is appreciable general body tone acquired. This also is contrary to the usual teachings.

The second result noted clinically is the fact that elevation of the stomach and colon does not always occur with fattening and that this elevation is not necessary to insure a permanently good end-result. The cases group themselves at a ratio of about nine to one into those cases where direct elevation of the stomach and colon is marked, and those where little or no elevation is obtained. This difference is noted well in the accompanying pictures. What underlies the difference in response we have not yet had an opportunity to determine. We do not believe it to be due often to adhesions holding down the omentum or transverse colon, for

Fig. 2.

Fig. 2a

Figs. 2 and 2a. These skiagraphs show the same effect as in Figs. 1 and 1a. Addition of 35 pounds in six weeks. Both patients remain in perfect health after one and one-half years.

Fig. 3.

Fig. 3a.

Figs. 3 and 3a. Illustrating type of case in which elevation of stomach and colon does not take place after fattening. Stomach, however, becomes tonic. Young woman. Weight increased from 115 to 154 pounds. Fig. 3a was taken 15 months after Fig. 3. End-results after two years, perfect.

Fig. 4.

Fig. 4a.

Figs 4 and 4a. Same type as case shown in Figs. 3 and 3a. The patient was a young woman. End-result perfect after one year. Forty pounds in weight added.

the reason that most of our cases of this group have been perfectly free from radiographic evidence of such binding. We are rather of the opinion that the fixation of the mesocolons is nearer the median line than usual or that possibly a non-obliteration of the omental bursa exists which permits of the permanent low position of the colon. In a few cases there has resulted marked elevation of the viscera in the presence of definite surgical barriers, which have prevented the relief of symptoms and caused general failure of an end-result. In one such case (H. S.) there exists an irrelievable mobile cæcum with a moderate ileal stasis, although the anatomical improvement is marked. This case must be treated surgically if an end-result is obtained. In a second case, with severe asthenia and ptosis, with pain and vomiting due to duodenal stasis, a marked anatomical result was obtained without relief, and at operation a band across the lower portion of the duodenum was found to be the cause of the trouble, as removal was attended with relief from the distress. As a rule it is not possible to add much weight or overcome the asthenic state in cases in which a surgical barrier exists, because the forced feeding soon brings about a violent upset with vomiting which does not permit further feeding. It is the recognition of this fact which has given us our surest means of differentiating surgical from medical cases.

The effect of fattening upon the cæcum is minimal. Mobile cæcum exists in two forms: first, where it occurs as a part of a general abdominal ptosis, in which at least the hepatic flexure has markedly fallen and where a distinct mesocolon with a median point of fixation exists; and secondly, the so-called true mobile cæcum of Wilms. The latter form is an elongated, usually dilated cæcum which lies over the brim into the cavity of the pelvis. It possesses no mesocolon and the ascending colon occupies its normal place on the inclined plane that forms the floor of the

Fig. 5.

Fig. 5a.

Figs. 5 and 5a. Illustrates the rather rare case in which the mechanical effects of fattening may be obtained in the presence of a mild surgical barrier. Young man with gain of 40 pounds in which a periodically irrelievable ileum stasis, believed to be due to bands, caused a failure of cure, four months after forced feeding.

kidney niche, and its peritoneum is fused normally with that of the parietal wall. In the former condition fattening will usually cause some elevation of the cæcum as shown in the picture of Miss R. Most of these cases are amenable to dietetic treatment; i.e., the cæcal stasis can be overcome. In the true form of mobile cæcum however, or in the other form when bound by adhesions, the stasis usually cannot be overcome and the case must be treated surgically.

The theme of this paper concerns essentially the second principle in the above general plan of treatment; namely, the part played by the deposition of fat. Inasmuch as the morbid states of fat metabolism or of tissue injury cannot enter into this plan of body upbuilding, the storing of fat has to do with the increase of the normal adipose tissue. In nearly all parts of the body the ordinary areolar tissue contains a variable quantity of fat tissue. Its distribution is not uniform, for in some parts it is collected in great abundance, as in the subcutaneous and subperitoneal tissues, the bone-marrow, and the liver. When the fat tissue is forcibly increased it collects for the most part in these locations, and is the direct result of the forced nutrition. The function of it, therefore, is essentially a physiological one; namely, a storehouse for excess body nutrition. But because the localization of it is largely within the abdominal cavity it serves a second important function which is purely mechanical.

When an undernourished ptotic patient in bed is rapidly force-fed, there is a progressive and corresponding gain in weight due largely to addition of fat to the body. The patient does not become materially stronger nor add to his reserve strength. He is distinctly fat and flabby. But during the first week or two of the fattening process there are marked radiographic changes which take place in the abdomen. The kidneys, stomach, and transverse colon become in the majority of cases rapidly elevated, and

Fig. 6.

Fig. 6a.

Figs. 6 and 6a. Illustrating type of mobile cæcum which is elevated somewhat by fattening, and in which a cæcum stasis is relievable. Young woman. Addition of 20 pounds and complete end-result after one year.

the dilated atonic stomach becomes normally contracted. The work of different observers has proved the existence of a constant but variable degree of intra-abdominal pressure. Whenever the general visceral mass is increased the intra-abdominal pressure is increased, other things being equal, in proportion to such increase of visceral mass; and as fat largely increases the visceral mass the increase of pressure is due to it. We have often noticed radiographically that as the fat is stored in the abdomen there is a corresponding reduction in the size of the atonic stomach. This has led to the belief that possibly the size of the stomach is directly influenced by the hydrostatic pressure within the abdomen; that is, the lower the pressure the larger the stomach and the more gases within it, and vice versa. I cannot believe this is wholly true, because the element of muscle tone enters as soon as forced feeding is instituted, by reason of the increased nutrition and the increased muscular work demanded of the muscular coats of the stomach. However, we do believe that this general visceral elevation and the overcoming of the atonic stomach does occur in the majority of instances before there is any appreciable increase in general body tone. The latter begins noticeably to appear only after physical exercising has been started; and also the amount of visceral elevation or the amount of stomach tone acquired does not increase very much by the subsequent overcoming of the general asthenic state. These points are well illustrated in the accompanying pictures.

The increase of intra-abdominal pressure and the building of the fat cushions chiefly about the kidney niches and the lower abdominal and pelvic walls which narrow the outlet, or the downward pointed cone of the abdominal cavity, probably is the greatest single factor in the mechanical elevation of the viscera. It has seemed to me, however, that a direct shortening of the mesenteries takes place also by the growth of the fat tissue within them. If a mesentery is largely

Fig. 7.

Fig. 7a.

Figs. 7 and 7a. Illustrating type of mobile cæcum (in this case bound by bands) without elevation of cæcum and with irrelievable cæcum stasis and failure of end-result.

Fig. 8. Illustrating Case 2.

Fig. 8a. Illustrating Case 2.

Fig. 9. Illustrating Case 3.

Fig. 9a. Illustrating Case 3.

devoid of fat it is reasonable to suppose that it would be somewhat longer than if it were liberally filled with fat-cells for the reason the mesentery is essentially a non-elastic connective-tissue structure. Dr. Sears has repeatedly observed the fact radiographically that the stomach and colon in the patient before fattening can be raised with the hand high in the abdomen, and when the pressure is released they immediately fall to the bottom of the cavity. After fattening, these organs, which now occupy a higher level in the abdomen, can also be raised practically as high as before, but on releasing the pressure they fall suddenly to their new level and stop there. They stop abruptly as one would expect them to do if they were supported by a loose ligament. Direct measurements, however, bearing on this supposition cannot be given at this time, so that it can only be assumed. The extreme elevation of the stomach and transverse colon, sometimes seen radiographically, also lends favor to such a view. The occasional observation as mentioned above, that the stomach and colon are not elevated at all, although there is an increase of the general visceral mass, increased tone of the anterior abdominal muscles, a decrease in size of the lower abdominal cavity, relief of the atonic stomach, and the acquiring of just as good a functional end-result as in the other cases, adds an interesting quandary to the whole subject. It is probable, however, that in such cases definite developmental mesenteric defects exist which counterbalance the effect of the other factors.

There are other logical results which may rightly be ascribed to the beneficent effect of the extraperitoneal growth of fat. Intestinal stasis is more easily overcome by reason of the increase of the visceral mass and the elevation of the viscera, probably for two reasons; first, there is a general increase in the tone of the bowel musculature, and second, there may be definite relief of mechanical barriers — a duodenal or an ileal stasis for instance. The support of the autonomic nervous system through the relief of the effects of stasis or the relief of mechanical drags must have some influence. The tender spastic colon as a rule progressively disappears as

Fig. 10. Illustrating Case 4.

Fig. 10a. Illustrating Case 4.

fat is added to the abdomen; that is, before there is an appreciable increase of general body tone.

An analysis of the physiological factor of fat deposition, i.e., of increased general body nutrition, is from a practical standpoint of easier interpretation. It affords the foundation for the development of general body tone by means of suitable physical training. Exercising without the preliminary foundation of excess nutrition always results harmfully. This factor is the basis of the fourth principle of treatment enumerated above, which makes possible the ultimate overcoming of the general asthenic state. It adds body tone generally and locally. It supports the autonomic nervous system and the ductless glands which surely play a vital influence in the development and maintenance of body health.

In closing I wish to refer briefly in a comparative way to the position which this plan of therapy occupies in relation to the well-recognized so-called Weir Mitchell rest cure. As intended by its author, this was essentially a rest cure for psychically imbalanced patients, for it consisted of absolute bed rest and isolation, together with various adjuncts, such as forced feeding with milk and the conserving of muscular strength by means of massage and faradization. But because of the numerous failures met with in its employment, many physicians began to modify it in this way and that to meet, as they believed, individual requirements. Indeed, so numerous have these modifications become that the sections on the treatment of neurasthenia found in most of the standard textbooks on general medicine contain oftentimes a medley of opposing therapeutic principles. DuBois and Déjerine have made of it essentially a treatment of psychotherapy under the favorable conditions of rest, isolation, and overfeeding. From the standpoint of the psychically disturbed patient this is surely logical and correct. The Germans, on the other hand, have laid most stress upon the fattening process, or *Mastkur*, as they call it, which is, it seems to us, illogical for both the psychically and the physically weak patient, for the former can neither be reëducated psychically, nor the latter be made physically

strong, by means of it. It has been our belief, a belief which has come to us by reason of our experience with patients, some of whom had been under the care oftentimes of very prominent neurologists and psychotherapeutists, without relief, that these failures have been due to the lack of differentiation between the psychically weak or neurasthenic patient and the physically weak or general asthenic patient. Our work has been for the most part with the latter group of individuals, because we have drawn them from the ranks of the general ptotics and those suffering from intestinal stasis. Psychical disturbances in these patients play distinctly a secondary rôle; in no sense are they to be considered psychasthenics. As soon as the toxic symptoms due to the stasis are relieved their nervous symptoms disappear of themselves and cease to give trouble, unless there is present a fundamental psychic disturbance, which fortunately is not very common.

To emphasize what has just been stated I take the liberty of citing briefly four illustrative cases, all of which have been at one time or another under the care of very prominent physicians, in this country or abroad, who failed to distinguish the physical from the psychical foundation of their ill health.

Four years ago Mrs. S., a widow of 61, suffered with the toxic symptoms of an extreme intestinal stasis; extreme headaches, body weakness, a weight of 87 pounds. This condition had existed for over forty years. Twice during the past ten years she had undergone protracted rest cures under a prominent Chicago internist, without result. For four years she has applied the above outlined principles with the result that her bowel is regulated, her headaches gone, she is stronger than she was at thirty-five, and her weight is around 130 pounds. Last spring she suffered a very severe influenzal infection which lighted up an old tuberculous infection of the lung, which at present seems to be becoming arrested.

Miss L., age 18, was a normal, healthy child until 14, when seemingly a ptomaine poisoning set up a chronic dysentery. She ceased to develop physically, became weak, with dry, pigmented skin. During the past four years she has consulted many physicians throughout the East. For the past year she was under the care of a prominent Chicago neurologist. Behind her dysentery was found an ileum stasis which we thought was due to bands, but it responded to dietetic measures and the girl rapidly gained from 74 to more than 100 pounds, her upper abdomen was expanded between four and five inches, and she is now continuously in school for the first time in four years. Her pictures show a really marked anatomical result. Her end-result in time is perfectly assured.

Mr. B., age 32, is a business man, who has been from early childhood a general asthenic. He had nervous breakdowns in school and later in his business life. For the past four years he has practically been unable to attend to his affairs because of headaches, dullness, and lack of strength and efficiency; he is generally constipated. During the summer he was advised by his physician, a neurologist of San Francisco, to set aside one more year in which to become rested and strong. His examinations showed a general ptosis with a general colon stasis of 96 hours; the chemistry of digestion was normal. He has since gained in weight from 137 to 179 pounds, his upper abdomen has expanded about six inches, his headaches are gone and he can box five three-minute rounds at a hard pace without tiring. His accompanying pictures likewise show a good anatomical result.

Miss Z., age 28, has always been from childhood frail, nervous, and morose. Two years ago she was taken to one of the foremost psychotherapeutists in Europe who considered her a psychically imbalanced patient. She did not remain long under his care, but entered a sanatarium in Germany, where she underwent a *Mastkur*. She was severely upset by the forced feeding as conducted there and did not recover for several weeks, when she was advised by her physician not to continue with it. I had examined this patient before she went to Europe; she in fact had prints of her radiographic examinations with her and showed them to the physicians consulted, but I feared the psychical element in her case and did not urge treatment under control at that time. More recently she has been treated in hospital, has gained twenty-five pounds in weight, has lost her nervousness and moroseness and is now taking up the more vigorous plan of physical training under the special physical director. Her anatomical result as shown radiographically is very marked.

ELEPHANTIASIS [1]

By L. L. HILL, M.D., LL.D., F.A.C.S., Montgomery, Alabama
Visiting Surgeon, Laura Hill Hospital

IN a paper that I published in the *Medical News* of Philadelphia, in 1894, I made the statement that elephantiasis was by no means a surgical curiosity among the negro race in this so-called "black belt" of Alabama. Twenty-one years of subsequent active surgical practice has not caused me to change my opinion. Elephantiasis is more common in adult life. It occurs three times as often among men as among women. Damp, malarious regions and bad hygienic surroundings, common conditions with the negro race here on cotton plantations, are important predisposing influences. Interference with lymphatic and venous currents, followed by a streptococcal infection, produces an obstructive lymphangitis which results in an œdema rich in active leucocytes, which, according to Robinson, not only become connective-tissue corpuscles, but also induce a hyperplasia of the fixed cells already present, producing a hardening and thickening of the skin with general connective-tissue hypertrophy and increased vascularity, but with muscular wasting. Without the erysipelatous infection there can be no fibromatous process, which is "the histological essential of elephantiasis."

Sabouraud is decidedly of the opinion that no morphological or clinical distinction can be made between the germ of this infection and Fehleisen's streptococcus, the streptococcus of erysipelas. One characteristic, however, is its tendency to remain in the obstructed zone and not migrate. Sir Patrick Manson says lymph stasis alone does not produce elephantiasis and has demonstrated the truth of his assertion by experimental ligature of lymphatic trunks. The obstruction may be congenital or due to filaria sanguinis hominis, cicatricial contractions, tumors, or tuberculous, syphilitic, or carcinomatous infiltration. It has been shown by Matas that the prevalence of elephantiasis in the tropics is due, not so much as was formerly believed to the initiative of filaria sanguinis hominis, but to exposure of the skin to injuries, irritants, insects, and frequency of eruptive diseases, all of which tend toward lymph stasis and dermal infection.

Though the parasite was discovered by Bancroft of Brisbane in 1876, to Sir Patrick Manson is due the credit of demonstrating that the mosquito was the intermediary host and man its definitive and the initiative connection of this snakelike organism in the production of elephantiasis. The parental worms and their premature products of conception are dangerous; but the fully formed microfilariæ, which are about the diameter of the red blood-corpuscles, circulate freely and are without any deleterious effect.

The examination of the blood should be made at midnight, as the microfilariæ begin to enter the peripheral circulation at six in the evening and, like the *danseuses* in a peacock alley, increase until twelve. Sir Patrick Manson explains this filarial periodicity by saying: "This night swarming of the larvæ of F. bancrofti in the peripheral circulation seems to be an adaptation correlated to the life habits of its liberating agent, the mosquito, culex fatigans, its usual intermediary host." In elephantiasis the enlargement of the affected part is steadily progressive and often reaches enormous proportions. The skin is coarse, darker than natural, and eczematous. Ulceration not infrequently occurs. The decomposition of the elephantoid discharges is very offensive. The elephantiasic fever is usually preceded by a rigor and I have seen the temperature reach 106° F. Its subsequent course is similar to the remittent type of malarial fever, differing, however, in that the fever is of greater severity. It usually continues about a week. Locally there is a distinct erysipelatous blush, with great tenderness. A milky exudation is often present. Such an attack is usually followed by a calm, which may last from a couple of weeks to several months, when there is another outburst, always leav-

[1] Read before the Medical Association of the State of Alabama, Birmingham, Alabama, April 22, 1915.

ing the part larger than before. In elephantiasis scroti the spermatic cord may become involved to the extent of dilating the abdominal ring, so that upon the subsidence of the swelling a hernia occurs.

The prognosis, so far as the life of the patient is concerned, is always very favorable, especially in this country; but the patient may be rendered miserable by the immensity of the growth, which sometimes weighs more than one hundred pounds.

Treatment. During the elephantiasic fever, give a saline purge or aperient along with sleep-producing drugs, such as morphine, aspirin, and sulfonal. Locally, there is nothing better than elevating the part and applying lead water and laudanum or a solution of the acetate of alum. The daily injection of fibrolysin, as recommended by Castellani, has been disappointing. Ligating the femoral artery to starve the growth, as was first performed by Carnochan of New York, in 1851, has fallen into merited disrepute. In 1908, Handley of England, by means of threads of unabsorbable silk, attempted to drain the obstructed areas into neighboring normal tissue; but two years subsequently he said, "To my mind lymphangioplasty has failed to establish its position in the treatment of elephantiasis." The principle of the operations of Lanz, Okel, and Rosanow is the establishment of a drain from the obstructed lymphatic area through the deep aponeuroses to the normal infra-aponeurotic lymph channels. To the attainment of this end an operation recently devised by Kondoleon of Greece is far preferable; this I will describe in the report of one of my cases.

My clinical experience with this disease is limited to ten cases, and, as most of them have already been reported, I will at this time confine my remarks to two recent ones that seem to me to be of especial interest.

CASE 1. T. S., forty-three years of age. I made a very extensive dissection of the lymphatic glands of the groin, which was followed by a slight enlargement of the penis and scrotum, but it was not progressive and his general health was perfect until six years later, when he had an attack of elephantiasic fever. The penis and scrotum rapidly increased in size until the former was nine inches and the latter twenty inches in circumference. I advised an operation, to which he readily consented. I made perpendicular incisions from the external abdominal rings and dissected out the testes and cords from the back of the scrotum, where they were imbedded in "a mass of lax, blubbery, dropsical areolar tissue." Turning the testicles and the "sacred highway so essential to the perpetuity of the race" upon the abdomen, I esmarched the scrotum and removed it practically in its entirety with the loss of very little blood. Bringing the organs into position, I covered them with the adjacent skin and, in the extensive loosening up, I was careful to expose as much as possible the deep muscular lymph spaces. Upon the dorsal surface an incision was made the whole length of the penis, and the penis freed of its covering. A very extensive dissection of the skin over the pubes enabled me to sew the pubic skin to the mucous membrane of the glans and it practically covered the organ. The wound healed readily, retains its reach when in action, and the owner says it is more than satisfactory. A few weeks after leaving the hospital the patient had a very mild attack of elephantiasic fever, soon followed by another. Dr. Charles M. Franklin and I gave him thirty-two injections of polyvalent antistreptococcic serum in doses of 10 ccm. at intervals of forty-eight hours, as recommended by Matas. It has now been several months since the last injection and Dr. Franklin has had him under constant observation and reports that he is attending to his professional duties and that his health is excellent.

CASE 2. R. J., negro, about forty years of age, was referred to me by Dr. Joe McClendon of Dadeville, Alabama. He had a typical case of elephantiasis of the left leg. It is no exaggeration to say that it was eight times as large as the right leg. I advised Kondoleon's operation. Making an incision from the external malleolus to the external condyle of the femur, extending through the aponeurosis to the normal muscle tissue, a strip of the "œdematous subcutaneous cellulo-adipose layer" three inches in width was removed the entire length of the wound. Turning back the aponeurosis for three inches, stitching the edges to the muscle the length of the wound, a direct communication was established between the supra-aponeurotic and the subaponeurotic lymph spaces, a distance of three inches in breadth, the entire length of the leg. This procedure was repeated upon the tibial side. In three weeks there was an appreciable shrinkage and Dr. McClendon reports four months after the operation: "His leg from the ankle up is doing exceedingly well, but on top of his foot and around his ankle there is a band of elephantiasis. The negro says he feels perfectly well and is able to do good work."

In closing this paper I cannot refrain from acknowledging my indebtedness for many facts to that distinguished American surgeon, Rudolph Matas.

A STUDY OF THE RELATION BETWEEN THE DEGREE OF MENSTRUAL REACTION IN THE ENDOMETRIUM AND THE CLINICAL CHARACTER OF MENSTRUATION[1]

By EMIL NOVAK, A.B., M.D., F.A.C.S., Baltimore, Maryland
From the Gynecological Department and the Laboratory of Gynecological Pathology of the Johns Hopkins Hospital

THE material which forms the basis of this study was obtained from a rather large series of cases in the gynecological department of the Johns Hopkins Hospital. At the very outset I wish to express my appreciation of the courtesy of Dr. Howard A. Kelly, head of the department, in placing at my disposal the wealth of material furnished by his clinic, and my very great obligation to Dr. Thomas S. Cullen, associate professor of gynecology and director of the laboratory, for his kindly and invaluable supervision of this work.

The point of departure in all present-day work upon the menstrual histology of the endometrium must necessarily be the epoch-making studies of Hitschmann and Adler (1), published in 1908. Whether they are to be given entire credit for thus revolutionizing our knowledge of this subject, or whether, as some maintain, this is in part due to earlier investigators (Westphalen, Kundrat, and Engelman), there can certainly be no question that to the two Vienna investigators belongs the honor of popularizing this teaching to such an extent that it now forms the basis of all histologic investigation of the endometrium. The principles arrived at by their studies are so well known that only the briefest possible mention is necessary at this time.

It will be recalled that Hitschmann and Adler were able to demonstrate quite clearly that the uterine mucosa undergoes a cyclical histological change which corresponds to the clinical cycle of menstruation. This developmental cycle in the endometrium they divide into four stages, as follows:

The post-menstrual stage, embracing the few days immediately following menstruation. During the latter it seems as if the endometrium empties itself, as it were, so that during the post-menstrual period its glands are narrow, collapsed, and straight, while the stroma is rather firm and compact (Fig. 1).

The interval stage is the term applied to the long period between the termination of the preceding stage and the beginning of the premenstrual phase, next to be described. During this period the endometrium is undergoing a steady but gradual development, the glands becoming fuller and exhibiting gradually increasing convolution. The stroma is still quite compact in appearance.

The premenstrual stage begins from a few days to a week or more before the next menstruation. At this time, according to Hitschmann and Adler, there is a sudden increase in the hypertrophic development of the endometrium. The lumina of the glands become much increased, presenting a characteristic scalloping on cross-section, while in longitudinal section they exhibit a dentate appearance (*sägeförmige drüsen*). In very marked cases there is a strong resemblance to the glands of early pregnancy (Fig. 2). The epithelium undergoes mucoid change, often appearing low and shreddy. The stroma cells participate in the general process of development, and in exaggerated instances may show such a protoplasmic increase as to simulate very closely ordinary decidual cells. More frequently, however, there is only a suggestion of this change, the cells being of a transitional type (*deciduaähnlicle zellen* or *übergangs-zellen*).

The menstrual stage, corresponding to the actual existence of menstruation, is characterized microscopically by appearances which are to be looked upon as a transition from those of the premenstrual period to those of the post-menstrual phase. In addition to the vascular phenomena characteristic of this stage, one finds usually that some of the glands are still very hypertrophic, while

[1] Read at the meeting of the Johns Hopkins Hospital Medical Society, May 17, 1915.

others already show the collapse characteristic of the post-menstrual stage. A similar transition is noted in the stromal tissue.

In the six years which have elapsed since the publication of the work of Hitschmann and Adler many articles have appeared in confirmation of their results, and a few in which a greater or less degree of contradiction is expressed. Among the more important of the latter may be mentioned those of Henkel (2), and Keller and Schickele (3). Both of these, however, have been very adequately answered in the recent exhaustive review of the subject by Hitschmann and Adler (4). At any rate, the weight of evidence at the present day is overwhelmingly in favor of the general correctness of their teaching, although on certain details there is still room for discussion.

The study of any considerable number of endometriums from this viewpoint must impress one with the striking differences in the degree of hypertrophic change brought about by the menstrual influence. All gradations are to be seen in the microscopic appearance in the so-called premenstrual period, from moderate glandular hypertrophy to the exaggerated glandular and stromal overgrowth which even suggests the appearance of decidua. In view of these wide variations in the degree of local hypertrophy, the question suggests itself as to whether these variations are in any way related to the well-known differences existing in different women with regard to the clinical character of menstruation. Aside from actual abnormalities of menstruation, there are women in whom the normal duration of the flow is perhaps only a day or two, the amount being very scanty. Other women, also entirely normal, may habitually menstruate 6 or 7 days, the flow being profuse. Other things being equal, does the endometrium in the latter type of woman exhibit a greater degree of menstrual hypertrophic change than the endometrium from the woman who menstruates very scantily? The incentive for the present study was derived principally from a consideration of the subject of these two queries.

Such a study as this must of necessity be one of comparison, and a proper basis for such comparison is the first desideratum. It would be of little value, for example, to compare the uterine mucosa obtained on the seventh or eighth day before menstruation with one which was removed only a day or two before the onset of the period. The time element in comparison can, however, be definitely fixed by comparing only endometriums removed on the same day of the menstrual cycle. The importance of accurate menstrual histories in the cases to be studied is obvious. So long as the periodicity of menstruation is undisturbed, it would seem to be wise to include in such a study, not only normal cases, but also those illustrating various forms of pelvic disease which might be capable of influencing the clinical intensity of menstruation; i.e., the duration and amount of the flow.

BASIS OF PRESENT STUDY

The cases upon which this study is based were selected from the records of nearly two thousand clinical cases admitted to Dr. Kelly's service between October, 1911, and October, 1913 (with the exception of a few earlier cases). From these were selected all those cases in which the endometrium had been removed, either by curettage or by hysterectomy. There were 339 cases of this kind. A considerable number of these were not suited for the purposes of this study on account of the insufficient amount of the scrapings. Others again were eliminated because of the fact that the histories were not as explicit as might have been wished from the standpoint of this study. This, of course, applies especially to the menstrual histories, for no case was admitted to the series unless it carried with it full data from this viewpoint — the age at which menstruation began, its regularity or irregularity, the intervals at which it recurred, the duration of the flow, its amount or severity, the occurrence or non-occurrence of pain, the presence or absence of clots, and last but not least, the dates of occurrence of the last two menstrual periods. Among other elements of the histories, especial consideration was given to the age of the patient, the date and

character of the operation, the pathological condition or conditions from which the patient suffered, her social condition (married or single), the number of childbirths, etc. By such a process of elimination as that indicated above, the number of cases in which the microscopic sections and the histories were found satisfactory was reduced to 268. The entire number of cases was now easily divisible into two main groups: viz., (1) those in which menstruation, whatever its other clinical variations may have been, still retained its regular periodicity, the interval of recurrence in the great majority of cases being, of course, 4 weeks; (2) those in which the menstrual rhythm had been broken, the periods recurring at irregular intervals. Cases of the latter group would be obviously unsuitable for an investigation in which the chronology of the menstrual cycle plays such an essential part, so that I have based this study upon the first of these groups, representing a total of 159 cases. The other group — the cases of atypical menstruation — numbering 109, I hope to make the basis of a later study.

As will be seen, the series of cases analyzed in this paper includes many types of pelvic lesion, in addition to a certain number in which the pelvic organs were described as normal. In all the cases, however, the menstrual cycle was undisturbed. In this connection, Hitschmann and Adler, as well as Schröder (5) and others, have shown that even local disease in the endometrium as a rule has no disturbing effect upon the menstrual cycle. In the great majority of my cases, however, the endometrium is quite free from any pathological alteration.

A moment's consideration will show that such a study as the one here attempted must of necessity be strongly tinctured with the personal element, and that it cannot be a mathematically exact one. For example, however intelligent a patient may be, and however conscientious the writer of the history, it is in many instances quite impossible for the former to recall or the latter to extract the exact date of a menstrual period which occurred two or three weeks previously. Fortunately, however, such an investigation as the present one is not vitiated by slight deviations in this respect, for we are concerned with the stages rather than with the specific days of the menstrual cycle. In describing the amount of the menstrual flow, it is even more difficult to fix a standard of comparison, but the three adjectives which I have used to designate varying amounts of the menstrual flow — "scanty," "moderate," and "profuse"—would appear to be sufficiently accurate for ordinary purposes when their use is based upon a consideration of the patient's entire history. The personal equation, again, enters into the appraisal of the microscopic findings, although this element is minimized when all the examinations are made by the same person. Even so, however, errors of judgment may arise from the fact that the menstrual hypertrophic change does not involve all parts of the uterus uniformly, but passes over the endometrium in a wave-like manner (Hitschmann and Adler). For this reason the hypertrophic changes may be considerably more advanced in one portion of the uterus than in another. The endometrium of the lower portion of the uterine cavity and that in the cornua is said to present less advanced changes as a rule than in the remainder of the uterus, for the reason that the pressure of the opposing uterine surfaces in these regions prevents full development of the glands. Again, curettings from the superficial compact layer of the endometrium are apt to give one the impression of a lower grade of gland hypertrophy than those from the deeper or spongy layer. In the preparation of curettings, bits of tissue from different portions of the uterus are sometimes brought side by side in the microscopic section, thus frequently giving rise to rather confusing pictures.

A condensed summary is given below of the series of 159 cases, divided into groups according to the day of the menstrual cycle on which the endometrium was removed. In designating the day of the menstrual cycle on which the endometrium has been removed, reference is made to the number of days which have elapsed since the first day of the last menstruation. The first day of menstruation is the one fixed date in the cycle of

normal, regular menstruation, and hence is the logical point of departure in a chronological study of the histology of the process. A statement is given of the microscopic findings in each group of cases — collectively where possible, individually where noteworthy differences exist between cases in the same chronological group. The terms applied by Hitschmann and Adler to the microscopic pictures at different periods of the menstrual cycle — post-menstrual, interval, premenstrual — have come to have a definite meaning to gynecological pathologists, and, for brevity's sake, I have used them wherever possible. By far the large majority of the cases are characterized by the four-week type of menstruation, but a small number (13) were marked by menstruation of other types, and these are included in a separate table.

It will be noted that throughout this paper much more stress is laid upon the glandular changes than upon those occurring in the stroma. The latter are not nearly so striking or so constant as the former, which would therefore seem to constitute the more logical and more convenient criterion of the degree of hypertrophic change in the endometrium. In only a comparatively small proportion of the cases is there such a striking overgrowth of the stromal cells that they are at all likely to be mistaken for genuine decidual cells. On the other hand, a greater or less degree of gland hypertrophy, easily appreciable on microscopic examination, is quite constant. It must not be assumed that the glandular phenomena are primary in character. Like other mucous glands, the utricular glands are merely reduplications of the mucous membrane, the evident purpose of which is to increase the secreting surface. When the glands show dilatation of the lumina and exaggerated infoldings, as they do in connection with the premenstrual hypertrophy, it is because the individual cells are swollen and overgrown. Room is made for these enlarging cells by increasing convolution of the glands. The full significance of the gland changes, however, will be discussed later in the paper.

It may be noted that there are few cases of cancer included in the series which I have studied. This is explained by the fact that in such diseases as cancer, menstruation is so frequently atypical, intermenstrual bleeding being observed sooner or later, and these cases have therefore been excluded from this series. It may be stated, however, that even in such pathological conditions as carcinoma of the cervix the menstrual cycle in the endometrium is usually unaffected, intermenstrual bleeding in such cases being evidently due to the destructive tissue changes characteristic of diseases of this type.

CASES OF THE FOUR-WEEK TYPE

First day: One case clinically diagnosed as salpingitis. Menstruation had commenced just a few hours before the operation (hysterectomy). Some of the glands are enormously hypertrophic; others are narrower. The stromal cells in many places show various grades of transition toward the decidual type.

Third day: One case, clinically diagnosed as stenosis of the internal os, with dysmenorrhœa. Endometrium shows a characteristically post-menstrual appearance, although relics of the premenstrual hypertrophy are seen as crumpled-looking gland lumina.

Fourth day: Five cases, including one of simple anteflexion, one of squamous-cell carcinoma of the cervix, one of pelvic inflammatory disease, one of uncomplicated myoma, and one of myoma complicated by adnexal inflammation. Endometrium typically post-menstrual in all cases.

Fifth day: Seven cases. Of these four were clinically diagnosed as pelvic inflammatory disease, one as myoma complicated by adnexal inflammation, one as intraligamentary ovarian cyst, and one as infantile uterus associated with dysmenorrhœa. Endometrium post-menstrual in all (see Fig. 1).

Sixth day: Nine cases, including five with pelvic inflammatory disease, one with laceration of the cervix and perineum, one with myoma complicated by adnexal inflammation, one with anteflexion, and one with menorrhagia not associated with demonstrable pelvic disease. In all these cases the endometrium presented the appearance characteristic of the post-menstrual or early interval period.

Seventh day: Eight cases. Of these the clinical diagnosis in four is pelvic inflammatory disease, in one multiple myoma, with adnexal disease, in one relaxed vaginal outlet, in one adenomyoma of the uterus, and in one retroposition of the uterus with congenital atresia of the vagina. Endometrium of early interval type.

Eighth day: Fifteen cases, including five of anteflexion, four of myoma with pelvic inflammatory disease, one of uncomplicated myoma, one of primary carcinoma of the left tube, four of pelvic inflammatory disease (in three of which there was also relaxation of the vaginal outlet). In some of these cases the glandular development was somewhat more advanced than in others, but the differences were slight, and all the specimens are classifiable as late post-menstrual or early interval.

Ninth day: Four cases, including one of anteflexion, one of myoma with adnexal inflammation, and two of pelvic inflammatory disease. In all these cases the endometrium was of the late post-menstrual or early interval type.

Tenth day: Four cases, including two cases of myoma with adnexal disease and two of pelvic inflammatory disease. In three of these cases the endometrium was of the characteristic interval appearance. In one of the four cases (Gyn. Path. No. 16,889), diagnosed clinically as chronic pelvic inflammatory disease, the glands are very narrow and straight; i.e., post-menstrual in type. The stroma shows the presence of many spindle cells, the interstitial tissue in places apparently encroaching upon the gland lumina. Numerous clumps of small blood-vessels are seen in the endometrium. Henkel lays much emphasis upon this as an evidence of chronic endometritis, although its importance is denied by Hitschmann and Adler. At any rate, this section is evidently one of chronic endometritis. It may be of further significance to add that although the hysterectomy in this case was performed on the tenth day of the menstrual cycle, it was done immediately after the cessation of a menstrual period, for the duration of menstruation in this case was 8 to 10 days.

Eleventh day: Three cases. Of these one was a case of hæmorrhage of puberty (no demonstrable pelvic disease), one of lacerated cervix and perineum and retroposition of the uterus, and one of myoma with pelvic inflammatory disease. In the last-named case the endometrium is of the post-menstrual type, the straight narrow glands being beautifully shown in longitudinal section (Gyn. Path. No. 18,883). In the other two cases the endometrium is of the interval type.

Twelfth day: Four cases, including two of anteflexion with dysmenorrhœa, one of large myoma with tubal inflammation, and one of mild subacute pelvic inflammatory disease. The endometrium from all these cases is of the interval type, but, contrary to what one might expect, the glandular development is considerably more advanced in the two cases of anteflexion (Gyn. Path. Nos. 18,518 and 16,670) than in the other two. This is especially true of Gyn. Path. No. 18,518. Clinically, menstruation in this patient was described as profuse, painful, and lasting five days.

Thirteenth day: Five cases, including one of uncomplicated myoma, one of myoma complicated by tuberculous peritonitis and tuberculous endometritis, one of double pyosalpinx, one of lacerated cervix and perineum, and one of retroposition of the uterus. In spite of the wide diversity in the pathological lesions present in these five cases, there is really no very striking difference in the picture presented by the endometrium, so far as the degree of glandular development is concerned. This applies even to the case in which there is local disease in the endometrium, that of tuberculous endometritis (Gyn. Path. No. 18,618). Leaving out of consideration the characteristic local manifestation of the tuberculous process, the glands in this case, as in the others of this group, are of the interval type.

Fourteenth day: Six cases, including two of anteflexion with dysmenorrhœa (the uterus being infantile in one of these), one of double hydrosalpinx, one of double tubo-ovarian abscess, one of multiple myomata, and one of infected ovarian cyst. While in all these cases the endometrium is of the interval

type, there are differences in degree of gland development. Especially noteworthy, perhaps, is the fact that, as in one of the groups already discussed, the glands are most developed in the two cases of anteflexion. Especially striking are the hypertrophic changes in Gyn. Path. No. 883, in which the hypertrophy and convolution of the glands are comparable to those seen in many cases during the "premenstrual" stage. The epithelium shows no mucoid change, and the stroma shows nothing of note except a moderate œdema in places. Menstruation in this patient was of five days' duration, free, and intensely painful. This group incidentally furnished a good illustration of the fact that even in the presence of undoubted pelvic infection the endometrium is apt to be found quite normal. This is well exemplified by Gyn. Path. No. 19,400, in which a double tubo-ovarian abscess is associated with a perfectly normal uterine mucosa.

Fifteenth day: Twelve cases. In this group are four cases of anteflexion with dysmenorrhœa: one of lacerated cervix and perineum; one of cervical polyp, lacerated cervix and perineum, and retroposition of the the uterus; two of pelvic inflammatory disease (one acute, one chronic); one of myoma with relaxed vaginal outlet; one of myoma with bilateral lutein cysts of the ovaries, and two of myoma with cervical polypi. The most conspicuous fact in connection with this group is that here again it is the cases of anteflexion which exhibit the greatest degree of hypertrophic change. In two of them (Gyn. Path. Nos. 16,633 and 19,001) the glandular hypertrophy is quite as pronounced as that characteristic of the premenstrual stage (see Fig. 3). The ages of the four anteflexion patients are 20, 21, 23, and 23. Two are single and two are married, but none of them has borne children. The significance of these facts will be emphasized later. Taken as a subgroup, the myoma cases, strange as it may seem, show much less hypertrophic change in the mucosa than do the anteflexion cases. As possibly bearing on this fact, I may say that in only one of the myoma cases is menstruation described as profuse, being spoken of as "moderate" in all the others, while, furthermore, all four cases of this subgroup are at or near the age of the menopause, although menstruation was still regular in all. The ages were, respectively, 39, 42, 47, and 55.

Sixteenth day: Five cases, including one of chronic appendicitis with dysmenorrhœa (pelvic organs normal), two of myoma with chronic appendicitis, one of relaxed vaginal outlet and retroposition of the uterus, and one of tuberculous salpingitis. The least developed glands are seen in Gyn. Path. No. 19,623, a case of myoma, in which menstruation was described as "moderate" and lasting three days. The greatest hypertrophy, on the other hand, is seen in the other myoma case (Gyn. Path. No. 18,837), in which menstruation lasted 5 to 7 days, and is described as profuse. The case of tuberculosis of the tubes (Gyn. Path. No. 18,559) shows no involvement of the endometrium. It illustrates very well the different appearances presented by different portions of the same specimens. In some places the glands show marked hyperplasia, so that the lumina are crowded closely together, with very little stroma between them. In other parts, on the other hand, there is only slight glandular increase, with moderate tortuosity.

Seventeenth day: Seven cases, including one of anteflexion, two of relaxed vaginal outlet, one of retroposition with relaxed outlet, one of cystic ovary, one of subacute pelvic inflammatory disease, and one of myoma complicated by pelvic inflammatory disease. No noteworthy differences as to glandular development are observed in this group, although perhaps the most decided hypertrophy is noted in the myoma case (Gyn. Path. No. 19,572). Clinically this case was characterized by profuse menstruation, the duration of which was 8 days.

Eighteenth day: Six cases, three being diagnosed clinically as anteflexion with dysmenorrhœa, and three as chronic pelvic inflammatory disease. This division into two groups affords an excellent opportunity for comparison. There is no question that glandular hypertrophy is much more marked in the anteflexion group than in the three

cases in which there was inflammatory disease (double salpingitis in two, light adhesions in one). As a matter of fact, the case in which the glandular change is most marked is one of anteflexion in which the uterus is of the infantile type (Gyn. Path. No. 13,140). The microscopic picture in this case is typically premenstrual (see Fig. 4). The age of this patient was 18, that of the other anteflexion patients respectively 18 and 22. Two were married and one single, but none had ever been pregnant. I emphasize this subgroup because it again illustrates the rather surprising frequency with which the endometrium in cases of simple anteflexion exhibits hypertrophic changes of much greater degree than those observed in association with even the most extensive pelvic lesions (see Fig. 5).

Nineteenth day: Four cases, including two of retroposition of the uterus (in both of these there was also relaxation of the vaginal outlet); one of anteflexion, and one of moderate prolapse of the uterus with chronic pelvic inflammatory disease. It is interesting to note that the three cases in which the history shows menstruation to have been profuse are characterized microscopically by decidedly more glandular change than the other two, in both of which menstruation was scanty.

Twentieth day: Four cases, including two of chronic pelvic inflammatory disease, one of uncomplicated myoma, and one of tuberculous peritonitis (no involvement of endometrium). In all these the endometrium is of the late interval type, showing considerable gland hypertrophy.

Twenty-first day: Six cases, including one of relaxed vaginal outlet, one of chronic endocervicitis, one of moderate prolapse of the uterus with relaxed outlet, one of myoma with double pyosalpinx, one of right pyosalpinx, and one of left hydrosalpinx. Of these the greatest interest attaches to the case of right pyosalpinx (Gyn. Path. No. 18,661). The clinical history of this patient speaks of menstruation as "profuse," the flow lasting 3 days. Microscopic examination of the mucosa after hysterectomy shows that the glands are very narrow, slightly convoluted. It appears that the lumina are being gradually obliterated by the preponderating interstitial tissue, which contains large numbers of round and spindle cells. In other words, we have to deal with a pronounced form of chronic interstitial endometritis, so marked as to suggest the appearance of a senile endometrium. The patient, I may add, was only 30 years old, and menstruation had been quite regular since the age of 13. The low grade of the gland changes in this case under the influence of the approaching menstrual period is perhaps explainable by the obvious subordination of the glands to the stroma in such an endometrium.

Twenty-second day: Fourteen cases. Five of these were diagnosed as anteflexion, four as chronic pelvic inflammatory disease, two as myoma with adnexal inflammation, one retroposition with lacerated cervix and perineum, one as tuberculous endometritis and salpingitis, and one as diffuse fibrosis uteri with polypoid endometritis. By far the most advanced gland hypertrophy is noted in Gyn. Path. No. 18,936, the case of retroposition of the uterus with lacerated cervix and perineum. There is a typical premenstrual hypertrophy of the glands, the epithelium showing mucoid change. This patient was a woman of 34, in whom menstruation had been for 8 years more and more profuse, sometimes lasting as long as 8 days. As a class the five cases of anteflexion showed glandular hypertrophy to considerably greater degree than the average found on this day of the menstrual cycle. This is especially true of Gyn. Path. No. 11,126, in which the microscopic appearance of the mucosa is typically premenstrual. Incidentally, this is the first section in this series which clearly illustrates the decidualike transformation (*decidua-ähnlichkeit*) of the stromal cells.

Twenty-third day: Two cases; one of simple retroposition of the uterus, and one of double pyosalpinx with an abscess of the uterine wall. The latter shows an endometrium which would be classed as of the late interval type, while the endometrium from the retroposition case, on the other hand, is typically and markedly premenstrual, showing much gland hypertrophy and also the characteristic decidual transformation of the stroma

cells. In both menstruation was described as profuse.

Twenty-fourth day: Three cases, including two of anteflexion with dysmenorrhœa and one of simple retroposition of the uterus. The two patients with anteflexion were unmarried; the other patient was married, but all were nulliparous. In none was there any other pelvic abnormality, and all of them suffered with dysmenorrhœa. They therefore present many points in common. In all of them microscopic examination shows considerable gland hypertrophy, most marked in Gyn. Path. No. 4250, a case of anteflexion.

Twenty-fifth day: Two cases; one of myoma complicated by adnexal inflammation and one of relaxed vaginal outlet with chronic appendicitis. While considerable hypertrophic change is evident on microscopic examination, it is not extreme. In the myoma case (Gyn. Path. No. 19,406), in which menstruation was profuse, the glandular changes are much more marked in the other (Gyn. Path. No. 17,020), in which menstruation is described as "moderate" in amount.

Twenty-sixth day: Two cases; one of complicated myoma and one of simple retroposition with chronic appendicitis. The myoma case (Gyn. Path. No. 18,500) shows moderate tortuosity of the glands, although the lumina as a rule are rather narrow. The stroma is compact, and contains many spindle cells. In spite of the myoma in this case, menstruation was moderate in amount, and lasted 3 or 4 days. On the other hand, the other case in this group (Gyn. Path. No. 19,521) yields an endometrium which is typically premenstrual. The glands are hypertrophic and convoluted, the epithelium is mucoid, the stroma cells are in places distinctly overgrown, and the stroma as a whole is œdematous. The subepithelial hæmatomata on which Gebhard laid so much stress are well shown in this section. In view of these facts, it is interesting to add that menstruation in this case was described as "excessive," its duration being 1 week.

Twenty-seventh day: Two cases; both of anteflexion with dysmenorrhœa and both illustrating beautifully in the microscopic pictures the exaggerated hypertrophic changes of the premenstrual period. In one of them (Gyn. Path. No. 19,361) menstruation was excessive, and the hypertrophic changes in this case are perhaps somewhat more marked than those in the other (Gyn. Path. No. 11,680), in which menstruation was moderate in amount (see Fig. 2).

Twenty-eighth day: Five cases. Among these were two cases of anteflexion with dysmenorrhœa, one case of chronic pelvic inflammatory disease, one of simple myoma, and one of complicated myoma. The endometrium in all the cases of this group, in which operation was done just before the expected onset of menstruation, exhibits striking hypertrophic changes. Both the cases of anteflexion show much gland hypertrophy, especially Gyn. Path. No. 17,024, which presents a full-blown premenstrual picture, in the sense of Hitschmann and Adler. In both of the myoma cases (Gyn. Path. Nos. 19,526 and 16,815) there is hypertrophy of the glands, but in neither is it excessive. In the former, menstruation was rather scanty; in the latter, profuse. Finally the case of pelvic inflammatory disease is characterized by well-defined hypertrophic changes.

CASES OF THE THREE-WEEK TYPE

Fourth day: Two cases; both of menorrhagia without demonstrable pelvic disease. In neither case was there any glandular hypertrophy.

Tenth day: One case of simple myoma, age 38, in which the endometrium was of the interval type. Menstruation in this case was described as scanty, the periods lasting 2 days.

Eleventh day: One case, also of myoma, in which there is some glandular hyperplasia, although the glands are as a rule quite narrow. The patient was 33 years old, and menstruation was profuse.

Fourteenth day: One case of menorrhagia of unknown origin in a patient of 30. For 8 months the patient had been menstruating every 3 weeks, although the amount is described as moderate. The endometrium is of the interval type.

Fifteenth day: Two cases. Of these one (Gyn. Path. No. 19,594) was a case of retro-

position with chronic endocervicitis (age 34), with excessive menstruation, the flow sometimes lasting 2 weeks. Considerable gland hypertrophy was noted in the endometrium. The other (Gyn. Path. No. 19,113) was a woman of 47 with climacteric bleeding. For 3 years she had menstruated every 3 weeks, the flow being profuse and lasting 7 days. Marked glandular hyperplasia and tortuosity are seen in the endometrium.

Sixteenth day: One case of simple myoma in a woman of 38. The menstrual flow was profuse, lasting 5 days. Marked glandular hypertrophy is shown by the endometrium.

Twentieth day: Two cases, including one of chronic pelvic inflammatory disease, and one of retroposition with cystic left ovary. In both of these cases menstruation was profuse and in both of them the endometrium shows striking hypertrophic changes. This is especially so of the case of retroposition (Gyn. Path. No. 19,425), in which a beautiful picture of the premenstrual type of endometrium is seen (Fig. 6).

CASES OF OTHER TYPES

Second week type. Only two cases were encountered in which menstruation recurred regularly every 14 days. In both of these cases operation was done on the eighth day of the cycle. One was a case of relaxation of the vaginal outlet, the other of chronic inflammatory disease. In both menstruation was described as profuse, and there is gland hypertrophy, especially in the case of perineal relaxation (Gyn. Path. No. 16,720).

Five week type. One case was encountered in which the patient asserted that menstruation occurred regularly every 5 weeks. It was a case of retroposition and relaxed outlet in a patient of 26, in whom operation was done on the fourteenth day of the cycle. The endometrium was of the interval type.

Three and one-half week type. In one case of myoma, complicated by left tubo-ovarian abscess, the patient stated that she had always menstruated at intervals of three and one-half weeks, the flow being described as "not profuse." Hysterectomy was done on the fifteenth day of the cycle. The glands seen in the endometrium are of the interval type.

WHAT THE STUDY INDICATES

A consideration of the results recorded in this synopsis will indicate, first of all, that another confirmation is added to the many which have been published in support of the general principle enunciated by Hitschmann and Adler; i.e., that from the end of one menstrual period to the beginning of the next the endometrium is undergoing a process of gradual development which reaches its climax just before menstruation begins. One or two details of this investigation, however, will bear discussion. While Hitschmann and Adler state that the premenstrual change is in the nature of a rather sudden flare-up, beginning from a few days to a week or more before the beginning of the next menstrual period, it has seemed to me that the developmental process is a very gradual one from one menstrual period to another, and that there is no sharp dividing line between the interval and the premenstrual stages, any more than there is any sharp transition between the post-menstrual and the interval phases. Whatever the stimulus to which the endometrial changes are due, its action seems to be a cumulative one, so to speak, reaching its acme just before menstruation. The latter is now generally looked upon as a destructive process, during which the endometrium drops from the highest to the lowest point of its development.

There are wide individual differences in the degree of premenstrual hypertrophy. The classical type described by Hitschmann and Adler is seen in only a part of the cases — just what the percentage is I am not prepared to state. Hypertrophy of the glands appears to be an invariable occurrence, but it differs much in degree. The same applies to the degree of mucoid change in the epithelium, which in some cases is very slight, in others extremely marked.

The stromal changes, as I have already remarked, are much less constant and, as a rule, much less striking than those in the glands. Œdema, contrary to the former opinion, appears to be without significance, for it occurs almost as frequently in the post-menstrual or interval periods as in the premenstrual. Its occurrence, like that of

blood, has been explained (Schröder) as due to traction on the uterus during the operation of curettage, and to other traumatism during this or other operative procedures. This, however, is only a hypothesis, and is not borne out by clinical experience. In many instances there is little or no appreciable hypertrophy of the stromal cells during the premenstruum. In a certain proportion of cases the transformation of the cells is very striking, so that they strongly suggest true decidual cells, but as a rule there is only a moderate degree of hypertrophy, the cells being of transitional type. The fully developed premenstrual picture of the classical type is very characteristic — much more so than that associated with any other period of the menstrual cycle. For example, I have never observed the premenstrual appearance, in the sense of Hitschmann and Adler, in any endometrium removed just after a menstrual period. On the other hand, I have frequently observed, during the period which chronologically corresponds to the premenstruum, only a very moderate degree of hypertrophy of the glands and perhaps no appreciable change in the stroma.

These last statements confront us again with the query which we set for ourselves as the main consideration of this paper. Do the wide histological differences in the endometrium at different stages of the menstrual cycle correspond in any way to the equally wide differences which exist among women with regard to the amount and duration of the menstrual period? A careful analysis of the cases in this series leads me to believe that, speaking generally, the greater the clinical intensity of menstruation the greater the local reaction in the endometrium, as manifested by hypertrophic changes in the glands, and to a less extent in the stroma. This statement is seen to apply as regards menstruation in association with all the various forms of pelvic disease above enumerated, *with the exception of one important group*. It may be noted in the above synopsis that when the various groups are studied from day to day of the menstrual cycle it is in those spoken of as anteflexion that the earliest awakening of the glands is observed, and that the premenstrual hypertrophy is apt to reach fullest development. This is rather remarkable in view of the fact that in many of these cases of anteflexion in young women, associated with dysmenorrhœa and usually sterility — and all the cases are of this type — menstruation as a rule is scanty rather than profuse. To determine definitely that this group of cases really does constitute an exception to the general rule which seems to apply to the others, it seemed wise, first of all, to compare all the cases showing definite hypertrophic changes in the glands, irrespective of the Hitschmann and Adler plan of division into stages. Special note is made of those exhibiting very marked hypertrophic changes, corresponding, for example, to the outspoken premenstrual picture. The picture in such cases may be spoken of as + hypertrophy. A third table presents the findings in the 33 cases of anteflexion alone.

THE "MENSTRUAL REACTION" IN CASES OF CONGENITAL ANTEFLEXION

A study of these tables shows how uniform it is to find hypertrophic changes beginning at an unusually early period in the menstrual cycle in cases of anteflexion, and how common it is to find that in this group of cases the hypertrophy is as a rule more marked than in other forms of gynecological disease operated upon at the corresponding stage of the cycle. Even if it were true that glandular increase may be due to inflammation, it would scarcely be conceivable that the anteflexion cases, above all others, should show such an inflammatory involvement of the endometrium. Moreover, the endometrium from cases of anteflexion in which operation was done early in the menstrual cycle shows the same picture — post-menstrual or interval — as does the endometrium removed at the corresponding period in cases in which various pelvic lesions are present (Fig. 1). The subsequent appearance of gland hypertrophy, therefore, must be looked upon as a cyclical developmental phenomenon and as being purely physiological in nature.

A better idea of the significance of these findings will perhaps be given by a consideration of the results from a percentage view-

TABLE I.—CASES SHOWING HYPERTROPHY OF GLANDS

Gyn. Path. No.	Age	Diagnosis	Day of Menstrual Cycle	Menstruation	Pregnancy
18,512	28	Anteflexion	12th	Profuse, 5 days	0
883	32	Anteflexion	14th	Free, 5 days	0
19,001	30	Anteflexion	15th	Profuse, 6 to 7 days	0
19,372	23	Anteflexion	15th	Scanty, 7 days	0
16,633	23	Anteflexion	15th	Scanty, 2 to 3 days	0
18,837	42	Myoma (complicated)	16th	Profuse, 5 to 7 days	2
18,559	27	Tuberculous peritonitis	16th	Moderate, 6 days	0
19,572	32	Myoma (complicated)	17th	Profuse, 8 days	0
16,938	41	Pelvic inflammation	18th	Moderate, 3 to 5 days	6
18,675	22	Anteflexion	18th	Moderate, 3 days	0
13,140	18	Anteflexion (infantile uterus)	18th	Profuse, 5 to 6 days	0
16,725	15	Pelvic inflammation	19th	Profuse, 5 days	1
16,928	22	Retroposition and relaxed outlet	19th	Profuse, 8 days	1
19,092	33	Pelvic inflammation	20th	Free, 3 days	0
19,450	38	Myoma (complicated)	21st	Profuse, 5 to 6 days	0
17,073	23	Hydrosalpinx	21st	Rather free, 4 days	2
19,132	41	Relaxed outlet	21st	Moderate, 5 days	1
16,634	34	Hydrosalpinx	22d	Profuse, 4 days	4
18,517	32	Anteflexion	22d	Profuse, 10 days	0
16,838	39	Fibrosis uteri and polypoid endometritis	22d	Moderate, 4 to 5 days	2
16,884	30	Normal generative organs	22d	Profuse, 5 days	0
11,388	19	Anteflexion	22d	Moderate, 4 to 5 days	0
19,371	33	Anteflexion	22d	Profuse, 4 days	1
18,523	24	Pyosalpinx and abscess uterus	23d	Profuse, 4 to 5 days	2
16,632	23	Retroposition	24th	Moderate, 4 days	0
19,139	27	Anteflexion	24th	Scanty, 5 days	0
19,406	42	Myoma	25th	Profuse, 8 to 14 days	0
17,020	24	Relaxed outlet	25th	Moderate, 4 to 5 days	2
18,500	30	Myoma (complicated)	26th	Moderate, 3 to 5 days	1
19,526	26	Myoma	28th	Scanty, 3 days	0
16,815	41	Myoma (complicated)	28th	Profuse, 7 days	3
17,017	42	Pelvic inflammation	28th	Profuse, 7 days	7

point. For example, of the 113 cases of pelvic disease of one form or another, other than congenital anteflexion, 26 (23 per cent) showed hypertrophy of the endometrium, including 5 (4½ per cent) with + hypertrophy. In the 26 cases with hypertrophy menstruation was profuse in 18 (69 per cent), moderate in 7 (27 per cent), scanty in 1 (4 per cent). In the 5 cases of + hypertrophy menstruation was profuse in all (100 per cent).

On the other hand, of the 33 cases of anteflexion 18 (55 per cent) exhibited hypertrophy of the endometrium, including 7 (21 per cent) with + hypertrophy. In the 18 cases of hypertrophy, menstruation was profuse in 7 (39 per cent), moderate in 7 (39 per cent) scanty in 4 (22 per cent). In the 7 cases of + hypertrophy menstruation was profuse in 1 (14 per cent), moderate in 5 (72 per cent), and scanty in 1 (14 per cent).

The two facts which seem to be brought out by this work are that (1), speaking gener-

TABLE II.— CASES SHOWING + HYPERTROPHY OF GLANDS

Gyn. Path. No.	Age	Diagnosis	Day of Menstrual Cycle	Menstruation	Pregnancy
19,326	35	Double tubo-ovarian abscess	1st	Profuse, 5 to 9 days	2
18,936	34	Retroposition, lacerated cervix, and perineum	22d	Profuse, 6 to 8 days	3
11,126	26	Anteflexion	22d	Moderate, 4 to 5 days	0
16,630	33	Anteflexion	22d	Scanty, 1 to 3 days	1
19,275	20	Retroposition	23d	Profuse, 4 to 7 days	0
4,250	22	Anteflexion	24th	Moderate, 5 days	0
19,521	38	Retroposition	26th	Profuse, 7 days	1
11,680	20	Anteflexion	27th	Moderate, 4 to 5 days	0
19,361	33	Anteflexion	27th	Profuse, 7 days	0
19,551	21	Bilateral tubo-ovarian abscess	28th	Profuse, 4 to 5 days	0
17,024	30	Anteflexion	28th	Moderate, 3 days	0
17,021	34	Anteflexion	28th	Moderate, 3 to 4 days	0

ally, the greater the clinical duration and amount of the menstrual flow the greater the degree of local hypertrophic reaction in the endometrium; and (2) that an exception to this general law is apparently encountered in cases of anteflexion of what is commonly called the congenital type; i.e., the type so frequently observed in young women and associated with dysmenorrhœa, rather scanty menstruation, and not infrequently sterility. These two statements deserve a further word of discussion, if only for the purpose of qualifying them, so as to make them seem less dogmatic.

The degree of menstrual hypertrophy with various pelvic diseases. Even in the presence of such conditions as adnexal infection and inflammation it is now generally recognized that the endometrium is in the great majority of cases quite normal. As far back as 1898 Cullen (6) reported a study of 1800 cases from the Johns Hopkins Hospital, only 49 cases of endometritis being found in this series. He emphasized the comparative rarity of this condition, even in association with well-marked pelvic inflammation. As far as mere glandular increase is concerned, Hitschmann and Adler make the statement that in many thousands of observations they do not recall a single case in which a new formation of glands was attributable to inflammation. As a matter of fact, it is difficult to comprehend how such a pathological increase could be recognized in view of the marked individual variations in different cases, and more especially in view of the constantly changing microscopic picture presented by the endometrium in the different stages of the menstrual cycle. Büttner (7) and Schröder (5) have also made interesting studies, as a result of which they reach the same conclusion as Hitschmann and Adler. The latter, it must be added, do not maintain that all the alterations of the endometrium are purely physiological, and that there is no such thing as endometritis. On the contrary, they emphasize the importance of endometritis of the interstitial type and admit the occurrence of pathological hyperplasia of the endometrium. The latter, as a distinct pathological entity, was first described by Cullen (8). It may occur at any age, but is most common between the ages of 40 and 50. It is invariably associated with profuse menstruation and at times with intermenstrual bleeding. The histological appearance is very characteristic. The mucous membrane is much thickened. Some of the glands are large and many of them dilated. This dilatation is not, according to Cullen, due to occlusion and cyst formation, as the gland epithelium is proliferated and high rather than low and flattened, as it would be in a retention cyst. Many of the enlarged glands are irregular in outline. The stroma is rich in cell elements and nuclear figures

TABLE III.— CASES OF ANTEFLEXION

Gyn. Path. No.	Age	Social Condition	Pregnancy	Day of Cycle	Menstruation	Endometrium
19,373	27	Married, 4 years	0	3d	Moderate, 2 days pain,	Postmenstrual
10,068	23	Unmarried	0	4th	Variable, 3 to 5 days, pain	Postmenstrual
4,196	23	Married, 3 years	0	5th	Not profuse, 3 to 4 days, pain	Postmenstrual
16,693	29	Married, 12 years	0	6th	Moderate, 4 to 5 days, no pain	Postmenstrual
13,378	20	Married, 2 years	0	8th	Moderate, 3 to 4 days, pain	Interval
19,324	22	Unmarried	0	8th	Scanty, 4 days, pain	Interval
19,052	23	Married, 2 years	0	8th	Moderate, 4 days, pain	Postmenstrual
9,027	20	Unmarried	0	8th	Free, 4 to 6 days, pain	Postmenstrual
18,677	24	Unmarried	0	8th	Moderate, 4 days, pain	Early interval
18,518	28	Married, 3 years	0	12th	Profuse, 5 days, pain	Hypertrophy
16,770	17	Unmarried	0	12th	Moderate, 3 days, pain	Interval
883	32	Widow	0	14th	Free, 5 days, pain	Hypertrophy
12,944	21	Married, 2 years	0	15th	Profuse, 2 to 4 days, pain	Interval
19,001	20	Unmarried	0	15th	Profuse, 6 to 7 days, slight pain	Hypertrophy
19,372	23	Married, 9 years	0	15th	Scanty, 7 days, no pain	Hypertrophy
16,633	23	Unmarried	0	15th	Scanty, 2 to 3 days, pain	Hypertrophy
4,156	19	Unmarried	0	17th	Scanty, 4 to 5 days, + pain	Interval
19,325	24	Married, 2 years	0	17th	Moderate, 5 days, slight pain	Interval
18,675	22	Married, 1½ years	0	18th	Moderate, 3 days, pain	Hypertrophy
13,140	18	Married, 2 years	0	18th	Rather profuse, 5 to 6 days, pain	Hypertrophy
19,596	22	Married, 9 months	0	19th	Scanty, 5 days, + pain	Interval
18,517	32	Married, 12 years	0	22d	Profuse, 10 days, pain	Hypertrophy
11,126	26	Married, 7 years	0	22d	Moderate, 4 to 5 days, no pain	+ Hypertrophy
11,388	19	Married, 1½ years	0	22d	Moderate, 4 to 5 days, + pain	Hypertrophy
19,371	33	Married, 15 years	1	22d	Profuse, 4 days, slight pain	Hypertrophy
16,959	23	Married, 5 years	0	22d	Scanty, 2 to 4 days, + pain	Interval
16,630	33	Married, 8 years	1	22d	Scanty, 1 to 3 days, pain	+ Hypertrophy
4,250	22	Unmarried	0	24th	Moderate, 5 days, pain	+ Hypertrophy
19,139	27	Unmarried	0	24th	Scanty, 5 days, + pain	Hypertrophy
11,680	20	Unmarried	0	27th	Moderate, 4 to 5 days, + pain	+ Hypertrophy
19,361	33	Married, 11 years	0	27th	Profuse, 3 days, pain	+ Hypertrophy
17,021	34	Married, 9 years	0	28th	Moderate, 3 to 4 days, pain	+ Hypertrophy
17,024	30	Married, 4 years	0	28th	Moderate, 3 days, no pain	+ Hypertrophy

can be detected if the sections are quickly hardened (Fig. 7).

A mere mention will suffice for certain other forms of gland change which are perhaps suggestive of pathological alteration, but which as a matter of fact are quite normal. For example, just after menstruation it is common to find transition types of gland, for during menstruation the dilated hypertrophic glands of the premenstruation undergo a rather rapid crumpling and shrinkage to form the narrow glands of the postmenstrual period. Before the "emptying" of the endometrium is complete the glands often exhibit a peculiarly pleated lumen, which has given rise to the term "zieh-harmonica-ähnliche drüsen." In the same way the invagination forms so often observed in the utricular glands were formerly looked upon as pathognomic of "endometritis glandu-

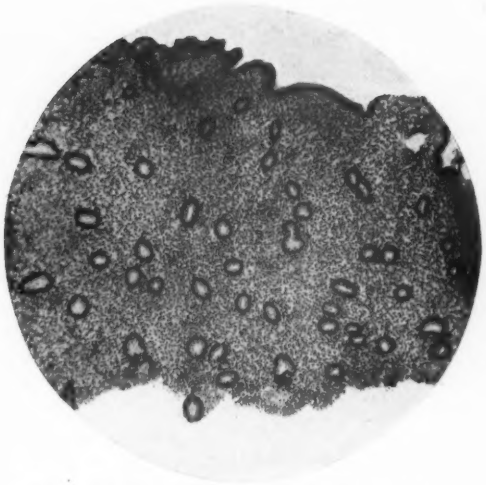

Fig. 1. Gyn. Path. No. 4,196. Endometrium from case of congenital anteflexion. Curetting on fifth day of menstrual cycle. Menstruation moderate, 3 to 4 days, painful. No hypertrophic change. Glands narrow and straight.

Fig. 2. Gyn. Path. No. 19,361. Endometrium from case of congenital anteflexion. Curetting on twenty-seventh day of cycle. Menstruation was rather profuse, 6 days, painful. Extreme glandular hypertrophy (premenstrual).

laris" (Himmelheber). Cullen and others, however, have shown quite clearly that these interesting and sometimes grotesque invagination appearances are produced by the manner of section of glands in which there is infolding or branching of the fundus.

The only previous study which I have been able to find on the relation of gland development in the endometrium to the clinical character of menstruation is by Büttner (7), whose paper is based on the analysis of 271 cases. Strange to say, Büttner excludes from his study all cases in which the endometrium was removed after the twentieth day of the cycle, ostensibly because he wished to avoid consideration of cases in which there was premenstrual hypertrophy of the glands. He thus, to my mind, misses the real crux of the problem, for it is especially after the twentieth day that the gradually increasing effect of the menstrual stimulus upon the uterine mucosa is to be noted. His study is further vitiated by the fact that he groups all the endometriums together, making no effort to divide them according to the day of the menstrual cycle on which they were removed. Even so, it appears that glandular hypertrophy was found in the largest proportion in the cases in which menstruation was clinically profuse.

What interpretation shall we put upon this relation between the degree of glandular hypertrophy and the clinical character of menstruation? The fundamental cause of normal menstruation is a stimulus arising from the ovary, or at least dependent upon its activity. It is associated with a certain degree of endometrial hypertrophy, and clinically with a type of menstruation characteristic of the specific case. If, then, we find an inordinate degree of endometrial hypertrophy in a patient in whom menstruation is excessive, are we justified in concluding that there has been in such a patient an excessive discharge of the substance or substances which are fundamentally responsible for menstruation — more especially of the ovarian hormone or hormones? On the other hand, is it logical to assume that ovarian activity is deficient when we find that menstruation is scanty and glandular hypertrophy slight? Such conclusions would seem to be quite unimpeachable if we could exclude the possibility that the variations in the

Fig. 3. Gyn. Path. No. 19,001. Endometrium from case of congenital anteflexion. Curetting on fifteenth day of cycle. Menstruation rather profuse, 6 to 7 days, pain. Definite though not extreme glandular hypertrophy.

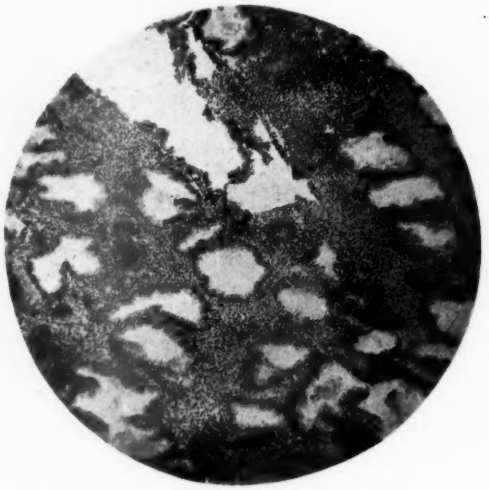

Fig. 4. Gyn. Path. No. 13,140. Endometrium from case of congenital anteflexion (infantile uterus). Curetting on eighteenth day of menstrual cycle. Menstruation moderate, 5 to 6 days, painful. Definite hypertrophy of glands in contrast with case shown in Fig. 5, with which it should be compared.

character of menstruation are at least in part due to variations in some local factor in the endometrium. This is virtually a broadening of the result arrived at by Hitschmann and Adler, who concluded that uterine hæmorrhage occurs only when the ovarian function is involved, and that it is never due to disease of the endometrium alone. For the evidence and arguments which they bring to bear on this problem I would refer the reader to their original paper.

The degree of endometrial hypertrophy in cases of anteflexion. A rather surprising finding in the series of cases under study has been the fact that in cases of what might be called congenital anteflexion the reaction of the endometrium to the menstrual stimulus is certainly not any less, and if anything is somewhat more marked, than in the cases of other pelvic disease of one form or another. The condition of congenital anteflexion is commonly looked upon as indicative of a greater or less degree of arrest of development of the uterus, and in some of my cases, indeed, the uterus is described as of infantile type. Menstruation was more frequently scanty or moderate than profuse. Dysmenorrhœa was observed in practically all the cases, and in those of the patients who were married sterility was almost invariable. In spite of the hypoplasia of the uterus in such cases, it was demonstrated that (1) in what may be called the quiescent portion of the menstrual cycle neither the glands nor the stroma exhibit any demonstrable differences in appearances or development from that observed in the fully developed or even the multiparous uterus at the corresponding period; (2) menstrual hypertrophy of the glands is noted at a comparatively early stage of the menstrual cycle, and may proceed to the development of the most marked premenstrual pictures; (3) such marked hypertrophy does not, in this group of cases, seem to bear any relation to the clinical severity of menstruation, for frequently the periods are described as scanty in amount.

Even though the uterus as a whole is hypoplastic, therefore, there is no indication of incomplete development on the part of the endometrium. As a matter of fact, it is more than ordinarily sensitive to the periodic physiological stimulation of menstruation. The real parenchyma of the uterus is the

Fig. 5. Gyn. Path. No. 18,911. Endometrium from case of bilateral salpingitis. Hysterectomy on eighteenth day of menstrual cycle, corresponding therefore to case illustrated in Fig. 3. Menstruation profuse, 6 to 7 days, pain. No hypertrophic changes in either gland or stroma.

Fig. 6. Gyn. Path. No. 19,425. Endometrium from case of retroflexion, with cystic left ovary. Curettage, suspension, and resection of left ovary on twentieth day of cycle. Menstruation of 3 weeks type, profuse, 4 to 5 days, pain. Well marked glandular hypertrophy (premenstrual).

musculature, and it is this which exhibits the hypoplasia in these cases of congenitally defective development of the uterus. If it be true, as seems to be indicated by the study of the first group of cases—i.e., those associated with various forms of pelvic disease—that the degree of endometrial reaction is a fair measure of the activity of the ovary, then certainly there is no diminution of the latter in these cases of congenital anteflexion of the uterus. This is contrary to the generally accepted theory, for the scanty menstruation and the spasmodic dysmenorrhœa so commonly observed in these cases are usually explained as being due to deficiency of the ovaries. So far as I know, there is no valid ground, experimental or otherwise, for the latter view. While the ovaries in such cases are sometimes rather small and beady, in other cases they are normal in size and appearance. Furthermore, we are all familiar with the fact that removal of one ovary, and perhaps also of a portion of the other, is quite compatible with the continuance of normal and perhaps even quite profuse menstruation. Finally, the view that hypoplasia of the ovary must accompany hypoplasia of the genital canal receives no support from a study of embryology, for the latter has an embryological origin quite different from the former. The ovary is developed from the so-called germinal ridge on the median surface of the wolffian body. On the other hand, the genital excretory system—i.e., the tubes, uterus, and vagina—is formed from the junction of the two müllerian ducts, these in turn arising originally from the "genital ridge" on the ventrolateral surface of the wolffian body.

Bearing in mind these several facts, it is scarcely to be wondered at that the present study leads us to the conclusion that even in congenital anteflexion or hypoplasia, associated with spasmodic dysmenorrhœa, scanty menstruation, and perhaps sterility, deficiency of ovarian activity is not a *sine qua non*.

DOES THIS WORK SUGGEST AN EXPLANATION OF THE CHARACTERISTIC CLINICAL SYMPTOMS OF CONGENITAL ANTEFLEXION?

A perplexing question presents itself at this point. If ovarian activity is not dimin-

ished in such cases, and if the endometrium exhibits well-marked hypertrophic phenomena, it would certainly seem that there must be a correspondingly marked menstrual hyperæmia of the mucosa analogous to that which is associated with similar hypertrophy of the endometrium in the well-developed uterus. Why, then, do we so frequently find scanty menstruation in cases showing perhaps extreme hypertrophy of the endometrium? The explanation which I would suggest is not based upon experimental data, and I offer it merely because it suggests future lines of work, while seeming to coincide with what we already know of the mechanism of menstruation. Without considering the latter in full, suffice it to say that hyperæmia of the uterine or endometrial blood-vessels is not sufficient in itself to explain the exit of blood elements, especially of the red corpuscles, from the blood-vessels toward and into the cavity of the uterus. Such a phenomenon would clash with all our ideas as to the usual simplicity of the process of hyperæmia. Even in the most intense hyperæmia associated with inflammatory processes, there is no such wholesale exodus of red corpuscles from the blood-vessel lumina to the surrounding tissues. No consideration of the physiology of menstruation can therefore be complete without the assumption — though as yet it is little more than an assumption—that a rôle of much importance is played by some local factor in the endometrium which in some way increases the permeability of the blood-vessel walls to the usual blood elements of the menstrual discharge. Just what this factor is, how it is formed, and how it acts has not as yet been determined. Much work has been done and is now being done in an effort to solve this problem, but so far the results are rather indefinite, and in some respects chaotic. For a discussion of this subject I would refer to the works of Goffe (9), Sturmdorf (10), Adler (11), Cristea and Denk (12), and others.

If it be true, as the study of the present series seems to indicate, that in congenital anteflexion there is no impairment of ovarian activity, the idea suggests itself that perhaps in these cases there is just as great a degree of menstrual hyperæmia of the endometrium as in those in which the uterus is well developed, but that in the former it is the local factor which is defective — in other words, that there is a physiological as well as an anatomic deficiency in the uterus. In such cases menstruation may be much less than the average because the blood elements do not pass out from the blood-vessels with the same facility as in the entirely normal uterus. This hypothesis would seem to explain the characteristic pain observed in cases of this type, for an engorged endometrium, unrelieved by menstrual discharge of blood elements, might be expected to act as an irritant of uterine contractions, much as a foreign body would. This conception is given further plausibility by the characteristic relief from pain which is noted as soon as the menstrual flow is well established. It is even possible that the sterility so often observed in those cases may in some as yet unknown way be dependent upon some local physiological deficiency in the endometrium.

The degree of bleeding, therefore, is dependent, not only upon the degree of endometrial hyperæmia, but possibly also upon the degree of activity of the local factor concerned in setting free the blood elements from the blood-vessels themselves. In the uterus which is anatomically and physiologically well developed, the local factor is unimpaired, so that the degree of endometrial hypertrophy is an index of the activity of the ovary, if this be conceded to be the organ responsible for the vasomotor phenomena of menstruation.

Speaking generally, the present study appears to indicate that the endometrium plays a subservient rôle in menstruation and that, with the exception of the one group of cases already spoken of, it is the activity of the ovary that largely determines the clinical character of menstruation and the degree of hypertrophy in the endometrium. This is another way of saying that in cases of endometrial hypertrophy, associated with profuse menstruation, the latter is the cause rather than the result of the hypertrophic changes in the endometrium. This conception is

not a new one. Many years ago Brennecke (13) described a group of cases of what he termed endometritis ovarialis, in which definite ovarian lesions were held to be responsible for the hyperplastic changes found in the endometrium. A similar explanation was offered in cases reported by Franz Czempin (14), Gottschalk (15), Winternitz (16), and Bulius and Kretschmar (17). The reports of all these authors, however, are invalidated by the fact that they took no account of the normal menstrual variations in the histology of the endometrium.

In the study described in the previous pages, however, in which due regard has been given to the physiological alterations in the endometrial histology, it seems to have been demonstrated that the endometrium plays a passive rôle, not only in normal menstruation, but in most of the pathological disorders of that process. Whatever the condition of the endometrium, whether normal or diseased, the constant and regularly recurring menstrual stimulus provokes characteristic changes in the labile endometrium, differing only in degree, as has been described in the body of this paper. If the function of the ovary be disturbed by general or local disease, if, in other words, menstruation is irregular, this characteristic histological cycle in the endometrium is correspondingly disturbed, with the production of atypical and sometimes confusing pictures in the endometrium. The "endometritis necrobiotica" recently described by Driessen (18) is obviously produced in this way, as probably also the old "endometritis fungosa" of Olshausen. No discussion of these atypical cases, however, will be undertaken in this paper.

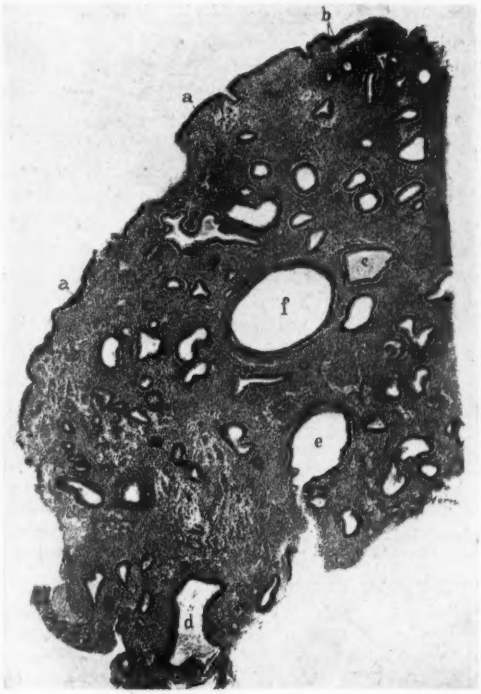

Fig. 7. Gyn. Path. No. 7026 (after Cullen). Hyperplasia of endometrium. Note dilatation of some of glands without flattening of the epithelium. The stroma between the glands is dense. "Given such a mucosa as this, one can say with almost absolute certainty that the patient has had very profuse menstrual bleeding." (Cullen.)

SUMMARY

The study of this rather large series of cases indicates, first of all, the general correctness of the teaching of Hitschmann and Adler as to the cyclical histological variations in the endometrium at different stages of the menstrual cycle. An interesting relation is shown to exist between the clinical character of menstruation and the degree of endometrial hypertrophy called forth by the menstrual stimulus. Speaking generally, the more profuse the menstrual flow the more marked the local hypertrophic changes in the endometrium. The less abundant the flow the less striking the local reaction in the endometrium. The latter must, therefore, be looked upon as playing an essentially passive rôle in menstruation.

An important exception to the above generalization is encountered in cases of anteflexion of what is commonly spoken of as the congenital type. In this group hypertrophic changes are, if anything, more marked than those noted in association with other pelvic conditions. This would indicate that the ovary, whose activity appears to govern the degree of hyperæmia and of consequent endometrial hypertrophy, is not functionally deficient in such cases, as has so often been

stated. The scanty menstruation so commonly observed in cases of this type is perhaps due to a deficiency in a local factor whose activity permits of the passage of blood elements from the vessels toward and into the uterine cavity. Such a theory would seem also to explain the spasmodic dysmenorrhœa so characteristic of congenital anteflexion, for the engorged mucosa, acting as an irritant to the uterine musculature, gives rise to spasmodic and painful contractions of the latter.

Sterility is also extremely frequent in association with congenital anteflexion. It is possible that future work may show that this is also in some way due to a physiological rather than an anatomical deficiency in the uterus.

On the whole the studies recorded in this paper, while in themselves along anatomical lines, tend to emphasize the fact that the physiological factor is of much greater importance in the consideration of menstrual disturbances than mere defects or alterations in the anatomic structure of the generative organs.

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PRIMARY CARCINOMA OF THE APPENDIX

A Review of the Literature, with a Report of Three Additional Cases[1]

By LEO B. MEYER, A.M., M.D., New York

Associate Surgeon, Mt. Sinai Hospital; Assistant Visiting Surgeon, Beth Israel Hospital and Montefiore Home

CARCINOMA of the appendix, which up to 1896 had scarcely been reported, has now a fairly extensive literature. Under the circumstances the placing on record of three additional cases might hardly seem justifiable were it not that so much confusion exists as to the exact place, both clinically and pathologically, the lesion should occupy, that every case should be reported in detail in the hope that a careful sifting and comparison of large numbers of accurate reports may help to clear up the subject. Up to the present time the question has been of more interest to the pathologist than to the clinician because of the relative non-malignancy of the condition, but the possible causal relation of carcinoma of the appendix to some cases of cæcal carcinoma and the report of an occasional undoubtedly malignant primary carcinoma of the appendix, make the study of the condition of more than academic interest, even to the clinician.

Before reviewing the recent literature on the subject, I wish to report the three following cases, operated upon at Beth Israel Hospital, New York City, Case 1 being operated upon by Dr. Henry Mann Silver, Cases 2 and 3 by the writer.[2]

Case 1. M. E., male, age 51, operated upon October 16, 1912. History of indefinite abdominal pains, more marked on left side. Exploratory laparotomy. Nothing found except an appendix with a hard, bulbous end. Appendectomy.

[2] Service of Dr. Richard Lewisohn.

[1] Read at a meeting of the Metropolitan Medical Society of New York, held at the Academy of Medicine, May 25, 1915.

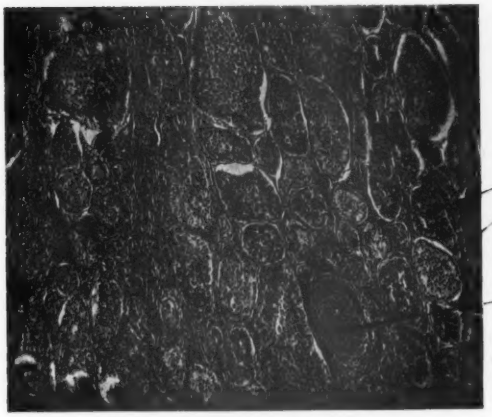

Fig. 1. a, Tumor; b, remains of lymph-nodes.

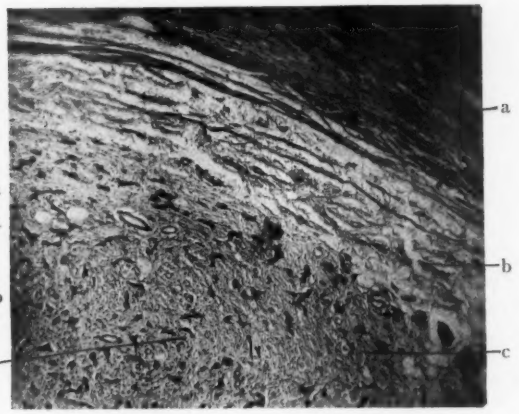

Fig. 2. a, Muscular layer; b, submucosa; c, tumor.

Pathological report (No. 3475) by Dr. Eli Moschcowitz, pathologist, October 16, 1912. Specimen: Appendix. *Gross examination:* The appendix is 7 cm. long, 1 cm. in average diameter; the distal end 2 cm., and bulbous. The peritoneal surface is smooth, except at the bulbous portion, where there are a few small nodules.

Transverse section through the bulbous portion shows it to be occupied by a solid growth, occupying the entire lumen and surrounded by both muscular coats, to which it is intimately connected. Longitudinal section shows tumor extending throughout the entire bulbous portion and slightly above it, where it merges rather sharply into the walls of the appendix. The tumor is firm, fibrous in appearance, light yellow-brown. The remainder of the appendix shows a slightly dilated lumen, otherwise normal.

Microscopic examination: The tumor shows an elongated structure imbedded in a concrete tissue stroma. The alveoli are irregular in size and shape, but the vast majority are circular or irregularly oval. The alveoli are filled with irregularly shaped cells of the epithelial type. The cell bodies are pale; the nuclei are round, fairly uniform in size, vesicular, and fairly rich in chromatin. A few mitotic figures are discoverable. The connective-tissue stroma is slight in extent compared to the epithelial element; it is fibrous and rich in eosinophile cells.

The tumor has invaded the muscular coats in all directions, and in one portion the mesenteriolum also shows slight infiltration. Scattered throughout are a number of lymphatic foci, apparently the remains of the lymphoid tissue of the organ. The remainder of the appendix is normal. (Fig. 1.)

Diagnosis: Medullary carcinoma.

CASE 2. M. G., female, age 19, operated upon February 1, 1914. History of attacks of pain in right iliac region for past four years. During past year attacks very frequent, and recently almost daily.

Pathological accession No. 4670, February 21, 1914. Specimen: Appendix. *Gross examination:* Appendix is 5 cm. long, diameter of a lead pencil, is uniform in thickness from the top to the base. The peritoneal surface is smooth; no adhesions. Section of the tip reveals a firm, solid mass occupying the lumen, surrounded by the muscular coat of the appendix. This mass is circular, measures 5 mm. in diameter, about 10 mm. longitudinally, and can be shelled with slight difficulty from the appendicular wall. Sections through the remainder of the appendix show a very narrow lumen throughout the entire length.

Microscopic examination: The tumor consists of numerous small alveoli, filled with epithelial cells enmeshed in an abundant connective-tissue stroma. The epithelial cells are small and spherical, the nuclei are uniform in size and circular and are rich in chromatin. No mitotic figures are visible. The connective tissue is more abundant than the epithelial elements and consists of many connective-tissue fibers and a moderate number of connective-tissue cells. The growth is limited within the muscular coats of the appendix and does not penetrate between the muscular fibers. The remainder of the appendix is normal. (Fig. 2.)

Diagnosis: Carcinoma simplex (scirrhous).

CASE 3. E. C., female, age 15, admitted November 27, 1914, to the hospital during an attack of acute appendicitis (first attack). Temperature, 103.6°; pulse, 136. Evidence of free fluid in peritoneal cavity. Leucocyte count 34,000, 96 per cent polynuclear cells. Operation: removal of gangrenous appendix; drainage.

Pathological accession No. 5496, November 27, 1914. Specimen: Appendix. *Gross examination:* Appendix 5 cm. long, 1 cm. in thickness; peritoneal surface is deeply congested, thickened, irregular, and

Fig. 3. a, Muscle fibers; b, tumor.

covered with fresh fibrin. The tip is bulbous, soft, partially necrotic and contains a very much dilated lumen filled with pus. Proximal to the tip the appendix upon section reveals an intensely inflamed mucosa, with infiltrated wall, especially beneath the peritoneal coat. The remainder of the appendix down to the base reveals a narrow lumen with infiltration of the muscular coats.

Microscopic examination: Sections were made (1) from the bulbous portion; (2) just above the bulbous portion; (3) near the base. (1) Section from the bulbous portion reveals the usual changes associated with an intense, acute, suppurative inflammation. The mucosa has been entirely destroyed. (2) Section just above the bulbous portion also shows acute suppurative inflammation. In addition, however, there is an alveolated epithelial tumor situated in the subperitoneal tissue. This area is crescentic in shape and extends around the appendix for about a third of its circumference. The tumor consists of smaller and larger irregularly shaped alveoli filled with cells of an epithelial type. The cells are irregular in size and shape, the outlines are indistinct, the nuclei are large, vesicular, and fairly rich in chromatin. No mitotic figures are present. The growth has penetrated into both muscular layers and partly also into what is left of the submucous connective tissue. In the latter situation the carcinomatous alveoli show partial necrosis due to the accompanying intense acute inflammation; the mucosa is completely absent and the lumen of the appendix is filled with an exudate. The connective-tissue elements of the tumor are fibrous, with few fibroblasts, and in extent about equal to the epithelial content. (3) Section through the base shows a fairly recent acute suppurative inflammation of the appendix. (Fig. 3.)

Diagnosis: Carcinoma simplex, with acute suppurative inflammation.

DIAGNOSIS

The pre-operative diagnosis is either an acute appendicitis (as in Case 3), a chronic appendicitis (as in Case 2), or the diagnosis is doubtful and the operation exploratory (as in Case 1). Carcinomatous appendices are occasionally removed during the course of an operation performed for another condition (as hysterectomy), and occasionally, though rarely, found at autopsy in patients who gave no history of appendicular trouble.

FREQUENCY

These three cases occurred in a series of 707 consecutive appendectomies, performed for either acute or chronic appendicitis, though a fair number of appendices were removed during laparotomies for other conditions. This means a percentage of about 0.42 of carcinoma of the appendix, all appendices removed being microscopically examined. In the literature the percentages reported vary from 0.33⅓ per cent to 1 per cent. The Mayo Clinic at Rochester, Minnesota, recently reported 40 cases in a series of 8039 consecutive cases, or about 0.5 per cent.[1]

HISTORY AND LITERATURE

The first case of carcinoma of the appendix on record is that reported by Merlin in 1838; in 1865 Prieri reported another; in 1867 Rokitansky reported four cases of colloid tumor of the appendix. Up to 1895 twelve cases had been reported, only one of which had been histologically described. During the next eight years only six cases were reported, for Moschcowitz (23), in an article in the *Annals of Surgery*, 1903, was able to collect only 18 cases in the literature, to which he added three more of his own. Elting in the same year reported three additional cases. By 1906 the number of cases reported had grown to 36 (Rolleston and Jones, 33); Zaajer in 1907 reported 60 cases, including eight of his own previously published. Since

[1] In a personal communication dated March 3, 1915, Dr. MacCarty of the Mayo Clinic says that up to date he has seen 45 cases of carcinoma of the appendix; that is, five additional to those previously published.

then reports have been very frequent, because both surgeons and pathologists have been on the lookout for the condition. Today in many hospitals all appendices removed are histologically examined, and in many others where this routine is not followed any appendix at all suspicious of tumor is examined; the condition is, therefore, much more frequently recognized than formerly.

In 1908 McWilliams (27), in a careful review of all the literature, collected and reported 105 cases, including his own. In 1913 Batzdorf and Graham (9) reported 170 and 172 cases respectively, the latter writer reporting six of his own. (H. Joseph, however, in 1911 had reported 186 cases, so that these writers evidently overlooked some cases.) Rogg (34) in 1913, in an exhaustive article, collected 201 cases. Since then I have been able to collect from the literature reports of 65 cases, as follows: Ries (37), Barclay (5), each one case; Schwartz (40 and 41), Baldauf (4), each three cases; Hada (10), six cases; Addison (3), one case; Graham (9), six cases; Miloslovich (24), three cases; MacCarty and McGrath (28 and 29) forty cases; Hanke (12), one case.

These sixty-five cases (together with the three reported by me), added to Rogg's 201, make a total of 269 cases on record at the present time. That the condition will frequently be missed, when only those appendices are microscopically examined which are suspicious of carcinoma, may easily be understood when one notes that of the 40 cases reported by MacCarty and McGrath only 10 per cent were suspected even after careful examination of the gross specimen. This fact helps to explain why, in four thousand routine post-mortems by Nothnagel and Maydl in the Allgemeine Krankenhaus, only two cases of carcinoma of the appendix were found.

Considering the age incidence, sex, frequency, symptoms and diagnosis, treatment and prognosis, the literature contains few differences of opinion; it is only when the pathology is considered that differences are found. The following is a brief résumé of facts gleaned from an extensive review of the literature.

Age. The majority of cases reported occurred in the third decade, and a good many in the second and fourth. A few cases were reported under ten years of age: one by Rogg (age 6 years) in 1913 and another by MacCarty and McGrath (age 5 years) in 1914. The oldest case was 81 years of age, reported by Rogg.

Sex. More cases are reported in females than in males (60 per cent to 70 per cent). This phenomenon is probably explainable by the fact that women furnish the pathologist with more appendices for examination than men because of the prevalent practice of removing the appendix during laparotomies for gynecological conditions. MacCarty and McGrath (29), in their last paper on the subject, report that 73 per cent of their forty cases of carcinoma of the appendix occurred in the female. If, as the majority of writers believe, carcinoma of the appendix is a sequel to inflammation of the appendix, it ought to be more frequent in men, as between 60 per cent and 70 per cent of appendicitis patients are men.

Symptoms and diagnosis. Most cases of carcinoma of the appendix are found in patients who have given symptoms of either an acute or chronic appendicitis. Some are found during the course of an exploratory operation for indefinite symptoms, the appendix being removed either because of a suspicious bulbous tip or hardness or as a matter of routine. Occasionally an apparently normal appendix, removed during an operation for some unrelated condition (as hysterectomy), is reported as carcinomatous by the pathologist. No authentic case in which a pre-operative diagnosis was made is on record. The only case reported in the literature in which it was claimed that the diagnosis was made before operation is the one reported by von Beger (6) and operated on by von Thiersch. Considerable doubt exists as to the actual condition present here. There was a palpable tumor and a sinus leading to a cancerous appendix; the case is considered by E. Müller as a cæcal carcinoma, but by some others as a cancerous appendix projecting into the cavity of the cæcum but not actually involving its walls (McWilliams, 27).

Treatment. When in the course of a laparotomy an appendix is found which is at all suspicious of carcinoma it should, of course, be removed. In fact, without entering into a lengthy discussion as to the advisability of appendectomy in all laparotomies, a disease incidence of 0.5 per cent, such as exists in this condition (aside from other reasons usually given), might be considered sufficient argument for recommending the removal of even apparently normal appendices. As carcinoma of the appendix occurs most frequently in appendices that are the seat of an acute or chronic appendicitis, which is the trouble that brings the patient to the surgeon, the appendectomy performed as part of the treatment of the appendicitis is, of course, the proper treatment for the other condition present. The report of the pathologist is usually the first inkling the surgeon has that he has removed a carcinoma of the appendix.

Prognosis. The prognosis is very favorable in a very large percentage of cases. Occasionally a type occurs in which the prognosis is not so favorable. The characteristic of this type will be discussed under the next heading.

Pathology. There is considerable difference of opinion as to the exact place of carcinoma of the appendix in relation to blastomatous development, in fact, some pathologists do not consider these growths as carcinomata at all. The points of agreement are as follows:

1. The growth is a very benign type, rarely spreading or making metastases.

2. It occurs most commonly in the third decade of life and is quite frequent in the very young, thus differing from the usual type of carcinomata.

3. It is more frequent in the female sex. While this view has been held by all writers to date, it probably needs revision.

4. The disease usually starts in the mucosa; its most common site is at or near the tip (90 per cent).

5. It occurs usually in an appendix which is, or has been, the seat of an appendicitis, and most commonly at the site of a stricture. There is a difference of opinion as to whether the carcinoma or the stricture is primary. Most authorities regard the inflammatory condition as primary and base their view upon the arguments that in other carcinomata of the intestinal tract complete obliteration of the tumor mass never occurs. The general consensus of opinion, therefore, is that the stricture is primary. Inasmuch as obliteration is probably always due to inflammation, a previous appendicitis may be considered the remote cause of cancer in the appendix, just as gastric ulcer, cholecystitis, lip and tongue fissures and ulcers are the precursors of cancers. Milner (20), however, dissents from this view, considering the stricture secondary. His entire conception of the condition differs from most writers, as he considers the growth an inflammatory proliferation of the lymphatic vessel endothelium, a hyperplastic chronic lymphangitis, and has applied to it the term pseudocarcinoma or carcinoid, analogous to the "Carcinoid Dünndarmtumoren" of Obendorfer. These tumors are all made up of epithelial cell groups, usually in the submucosa, but sometimes extending to the peritoneum, and are without clinical significance. Aschoff (1 and 2) calls them "Schleimhaut Nævi," or nævi of the mucous membrane, and while laying stress on their benignancy thinks that occasionally they may change their characteristics and become malignant in the same way as nævi in other situations. Marchaud (21 and 22) and Dietrich (8) both consider the growth as a genuine epithelioma.

Rogg (34) considers these "Schleimhaut Nævi" as typical carcinomata and sees no reason to question this conception because of the clinical picture, pointing out that there are all grades of malignity, from the relatively benign rodent ulcer to the malignant type of gastro-intestinal carcinoma. Furthermore, whereas practically all these cases are benign,[1] sight must not be lost of the fact that malignant cases have been reported. In the majority of these cases the cæcum is involved, and doubt, therefore, exists as to whether the growth was primary in the cæcum or in the appendix. But there are some undoubted cases of primary carcinoma of the appendix in which metastases and death have occurred.

[1] None of the forty-five cases observed at the Mayo Clinic showed any extension or metastases. (Personal communication from Dr. MacCarty, March 3, 1915.)

It is also probable that some, though few, cases of cæcal carcinoma are secondary to a primary growth in the appendix, though MacCarty, in a report of twenty cases of carcinoma of the cæcum, found only one which may have been secondary to a primary growth in the appendix.

Lejars (16) reported a case supposedly limited to the appendix at the time of operation, followed by recurrence within three months. This is the first undoubted case of recurrence following operation for this condition in which the appendix alone was involved at the primary operation and in which diagnosis was confirmed by microscopical examination. Two cases were reported, one each by Lanz (17) and Ruyter (38), in which the appendices were not microscopically examined, but the recurrences were microscopically carcinomatous. Because of cases like this, and also because of the occasional though rare presence of involved glands in the meso-appendix, McWilliams advises a wide removal of the meso-appendix in all appendectomies instead of its removal close to the appendix, as is frequently practised.

Luce (18) collected twenty-three malignant cases and reported two of his own; only ten of these he considered as undoubtedly primary in the appendix; the origin of the remaining cases was doubtful. G. C. Ross (36) reported a very interesting case two years ago, somewhat analogous to Lejars' case but with a much more rapid development. There was a history of chronic appendicitis, and an appendectomy was done; the lymph-nodes of the meso-appendix were enlarged. One week after discharge from the hospital the patient was readmitted, with a large mass in the lower abdomen and one in the abdominal wall. Microscopical examination of these masses showed carcinoma of the same type as that of the removed appendix.

As gleaned from the literature, there are various types of growth found in these cases. According to some writers, the character of the cell is different in those cases that have been followed by mestastases. The majority, however, make no attempt at differentiation of pathological types but content themselves with emphasizing the non-malignant character of the condition and refer only casually to the possibility of metastases in rare cases.

The following types have been reported:

1. Colloid carcinoma of the appendix (4 per cent).
2. Small, round-celled or spheroidal-celled carcinoma, carcinoma simplex or scirrhous, the most common form, and usually the type in young. Non-malignant (53 per cent).
3. Cylindrical-celled carcinoma—occasionally but rarely followed by extensions or metastases. This form is much less common than the second and resembles in character the ordinary type of intestinal cancer (23 per cent).
4. Mixed types (4 per cent).
5. Endothelioma (37 per cent).
6. Transition forms (10 per cent).

While in the above classification [1] an attempt is made to indicate which type is more malignant, I hardly think it worth while to place any reliance on this, as the evidence is altogether too meager.

Miloslowich (24), however, insists that one must not lose sight of the fact that there are two distinct types of this condition: "a small, non-malignant tumor, and a cylindrical-celled cancer, which in its anatomic and histologic as well as clinical picture is similar to cancer (*drüsen Krebs*) in other parts of the intestinal tract." Graham (9), in an article reporting 172 cases, of which 35 belonged to the columnar-celled type, refers to 6 malignant cases among these 35, reported by Beger, White, Voeckler, Neugebauer, Bertels, and Marsh.

SUMMARY

The whole matter may be summed up as follows:

That in carcinoma of the appendix we have a condition, formerly believed to be very rare, but now known to occur in about 0.5 per cent of all removed appendices. It is a condition never recognized before operation and usually unrecognized at the time of operation. (Only about 10 per cent of removed appendices are suspected before being sent to the pathologist.) Furthermore, while up to the present time the condition has been

[1] Classification and percentages as in article by McWilliams (27).

considered as histologically malignant, but clinically benign, it must be recognized that clinically malignant cases do occur. The condition is therefore of sufficient importance to warrant intensive study of all cases. Only by such study can our knowledge be increased, so that some day a clinical diagnosis may be possible. It is not impossible that some carcinomata in the abdomen in which no primary growth is discoverable, e.g., carcinoma of the peritoneum, a non-epithelial organ, may be secondary to carcinoma of the appendix.

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A SIMPLIFIED METHOD OF BLOOD TRANSFUSION WITH REPORT OF SIX CASES OF PERNICIOUS ANÆMIA TREATED BY MASSIVE BLOOD TRANSFUSION AND SPLENECTOMY[1]

By NELSON MORTIMER PERCY, M.D., F.A.C.S., Chicago

In September, 1913, the writer encountered a case of septicæmia in a child on which it seemed wise to make a blood transfusion. Previous to this time I had used Crile's method of direct transfusion, but on account of technical difficulties and the uncertainty of the amount of blood being given, if any, the method had not proved satisfactory in my hands. This method was especially contra-indicated in this patient, because of the likelihood of contaminating the donor from the recipient.

In the *Journal of the American Medical Association* of July 12, 1913, Kimpton de-

[1] Read before the Chicago Surgical Society, May 7, 1915.

scribed an indirect method of blood transfusion, by draining off blood from the radial artery into a paraffin-coated tube, designed by Brown, and injecting this blood into the median basilic vein of the recipient. The tube to be described is a modification of the Brown tube, which was modified with the object of making a venous transfusion tube and also a tube more easily constructed. The tube consists of a glass cylinder 4 cm. in diameter, with a cannula leading from one end, the other end being drawn out into a tube about one cm. in diameter to which a Y connection is made. To one arm of the Y, a rubber tube is attached for suction to aid in filling the tube, and to the other arm a rubber bulb is connected to aid in injecting the blood. The tube differs from the Brown tube in that there is no side tube coming off from the cylinder, and the upper end of the cylinder, instead of being closed with a large cork, is drawn out into a tube for the Y connections as described above. The cannula part of the tube is so constructed that it can be inserted directly into the vein of the donor and then the recipient. An open dissection of the vein of both donor and recipient is made for two reasons: First, if the operation were done subcutaneously, it would be necessary to use a needle with a rubber connection to the cannula, which connection would make a roughened area which would favor clotting, whereas, with the smooth, paraffin-coated cannula there is no such tendency. Second, after the tube is filled with blood, the cannula can be inserted into vein of the recipient without delay, an essential feature after blood has been withdrawn.

The dangers of transfusion are two; i.e., immediate and delayed. The immediate dangers are embolism either from air or clotted blood, or acute dilatation of the heart consequent to such rapid inflow of blood that the recipient's heart is overwhelmed. The delayed danger is that from hæmolysis, which danger cannot always be eliminated by the most careful tests prior to the operation.

A hæmolytic test of each blood upon the other should be made before transfusion, because it has been found that in a small percentage of cases there is a tendency of the serum or corpuscles to cause a disintegration of the red cells of the blood from another individual even when the latter be a near relative. This is especially likely to occur in cases of tuberculosis. Crile states that it happens in 5 per cent of patients suffering from tuberculosis. Bernheim states that in 800 reported transfusions there were fifteen instances of macroscopic hæmolysis. In these fifteen cases there were eleven recoveries and four deaths. No hæmolytic tests were made in three of the instances where death occurred. In the fourth case tests were made, and it was known that the donor's cells were slightly agglutinated by the patient's serum but since agglutination is an entirely different process from hæmolysis, it was considered fairly safe to use this donor, and a fatality occurred. Tests were made in eleven of the fifteen recoveries and in nine instances hæmolysis was prognosticated.

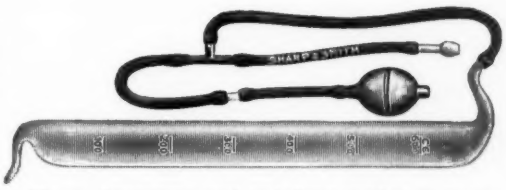

Fig. 1. Instrument used in indirect method of transfusion of blood.

The writer's experience with both hæmolysis and agglutination tests differs from these findings. In both of the cases where fatal hæmolysis occurred the hæmolysis tests were absolutely negative. In the patient who showed slight reaction, both the hæmolysis and the agglutination test, as described by Rous and Turner, were perfectly negative. In another case which showed a beautiful, unmistakable agglutination (Rous-Turner), but negative hæmolysis, transfusion of 800 ccm. of blood was performed, smoothly and without the slightest sign of any discomfort to the recipient. Only once has the hæmolysis test been positive. In view of these facts, the author deems it essential to make, in addition to these tests, a preliminary transfusion of 20 ccm. of blood, believing that this amount of blood will indicate hæmolysis, if it is to occur, without serious sequelæ.

Besides making a test for hæmolysis, a careful history should be obtained from the donor, and if at all suspicious, a Wassermann reaction should be made. Donors should not be chosen from persons giving a history of recent attacks of typhoid fever, pneumonia, diphtheria, tonsillitis, malaria, or influenza, or from persons suffering from tuberculosis, chronic arthritis, rheumatism, or where there is a history of hæmophilia.

The agglutination test we use is that described by Rous and Turner.[1] The hæmolysis test we use is as follows: Ten ccm. of blood is collected from a vein of the donor (D), 5 ccm. of which is placed in a dry centrifuge tube and allowed to clot and the remaining 5 ccm. mixed thoroughly with 10 ccm. of a one-half per cent sodium citrate solution in normal salt solution. The latter solution preserves the red cells and prevents clotting. Both tubes are now rapidly centrifuged. In one tube the clotted blood will separate, leaving a clear serum as an upper layer; 1 ccm. of this serum is then added to 9 ccm. of normal salt solution in a test tube and labeled 10 per cent solution of D's serum. The other centrifuge tube now contains a compact layer of red cells in the bottom and an upper clear layer of mixed serum and salt solution. This upper layer is carefully poured off and the same amount of fresh normal salt solution is added with a pipette so as to mix the cells. The tube is again centrifuged. This procedure is repeated ten or twelve times in order to thoroughly wash the red corpuscles free of serum. Finally, 1 ccm. of the corpuscles is mixed with 9 ccm. of normal salt solution in a test tube and labeled 10 per cent suspension of D's corpuscles. Ten ccm. of blood is collected in the same way from the recipient (R), and a 10 per cent solution of serum and a 10 per cent suspension of cells are prepared as above and placed in separate test tubes. These four 10 per cent solutions and suspensions are used in setting up the test.

In a clean test tube 1 ccm. of D's serum is mixed with 1 ccm. of D's corpuscles. In a second tube 1 ccm. of R's serum is mixed with 1 ccm. of R's corpuscles. These two tubes are used as controls. In a third tube 1 ccm. of R's serum is mixed with 1 ccm. of D's corpuscles. These four tubes are placed in the incubator at 37.5° C. for two hours, during which interval the tubes are shaken several times. They are then placed in the ice-box for twelve hours and shaken occasionally to insure mixing. If the blood-cells remain as a layer in the bottom of the test tubes and there is a clear, nearly colorless fluid above, or if the tube, when shaken, be quite cloudy and not transparent, there has been no hæmolysis. If there are no red cells present as a layer, or if the shaken tube is clear, there has been hæmolysis of the red cells. The two control tubes should show no hæmolysis. If they do, there has been an error in technique.

[1] J. Am. M. Ass., 1915, June 12.

PREPARATION OF TUBE

The tube should be cleansed by washing with water, alcohol, and then with ether, and, after it is perfectly dry, two ounces of melted grocer's paraffin is poured into the tube through the upper end. It is then wrapped in a towel and placed in a steam autoclave for fifteen minutes under fifteen pounds of pressure, after which, with sterile rubber gloves over the hands, the tube is rolled around while cooling so that every part of the inside is covered with melted paraffin and any excess allowed to run out of the large end "D." Care should be taken not to allow the cannula to become plugged with paraffin. If it does, the tip is warmed over a flame and the paraffin allowed to run back into the tube. Sterlizing the rubber tubing, glass Y, and mouth piece is done by placing them in a towel and autoclaving in the same way and at the same time as the transfusion tube, or boiling them for twenty minutes. The atomizer bulb is thoroughly washed with alcohol to sterilize it. When ready to use, the connections are all made and two ounces of sterile liquid paraffin aspirated into the tube through the cannula by means of suction at the mouth piece.

TECHNIQUE OF TRANSFUSING THE BLOOD

The arms of both the donor and the recipient are prepared as for surgical operation.

Proper constriction of the donor's arm is essential if one wishes to draw off a large quantity of venous blood rapidly. Constriction by means of a rubber tube is not satisfactory because the amount of pressure is not known, nor can the pressure be varied as desired. An ordinary blood-pressure apparatus placed about the arm and pumped up to 60 to 80 mm. of mercury, depending upon the rapidity with which the blood flows, makes an excellent constrictor. By this means the venous circulation is impeded, but not the arterial. It is imperative to use a separate set of instruments on different tables for donor and patient in order not to transmit infections from patient to donor. Under local anæsthesia, using one-half of one per cent novocaine solution intradermally, an incision is made over the cephalic vein just above the elbow on both the donor and the recipient, and a ligature placed about the vein in its proximal portion in the donor and in its distal portion in the recipient. Small Carrel clamps are placed on that portion of the vein away from the ligature in each patient and a longitudinal incision 3 mm. long made through all coats of each vein midway between clamp and ligature. Small retention clamps are placed on the two edges of the incision in each vein in order to hold them open. The cannula is placed, pointing distally into the vein of the donor, and the Carrel clamp released from the vein. By means of suction at the mouth piece, venous blood is drawn into the tube up to the required amount. The blood is well protected from the sides of the glass by the paraffin coat and from the air by the liquid paraffin which floats over and completely covers the blood. As soon as the tube is filled, which in our experience averages about three and one-half minutes to withdraw 600 ccm. of blood, the aspirating tube is clamped, the cannula removed from the vein and the small clamp reapplied to the donor's vein.

The cannula is now quickly placed in the lumen of the vein of the recipient and the Carrel clamp released. The blood will now flow into the vein of the recipient toward the heart, the velocity of which flow may be controlled by careful pumping of the rubber atomizer bulb. As soon as it is evident that the blood is flowing properly, an assistant may release the constrictor from the donor and ligate the vein distally to the opening from which the blood has been taken. Not more than five minutes should be utilized in obtaining the blood, nor more than five minutes in injecting it. The length of time required to fill the tube with blood varies with different donors. It is well to have two tubes ready, so that if it is found that the first tube fills slowly, taking more than five minutes to get the required amount, the process may be repeated with second tube, aspirating only the remainder of the required amount of blood.

QUANTITY OF BLOOD

In cases of hæmorrhagic purpura and hæmophiliacs small quantities of blood give results. For other conditions large quantities of blood such as 500 to 1000 ccm. are indicated. In cases of acute shock accompanied by considerable loss of blood, 1000 ccm. may be given with advantage, while for the chronic conditions it is our custom to give 500 to 850 ccm. at one time. The amount given to children varies with the age, similar to the dosage of drugs.

INDICATIONS

Some of the conditions in which the blood transfusion therapy may be considered are: splenic anæmia with hæmorrhages; secondary anæmia of both known and unknown origin; in pernicious anæmia where its effect is merely temporary unless combined with splenectomy; in purpura and hæmophilia; acute surgical shock, especially in emergency cases where it is necessary to perform major operations; as a preliminary measure to decrease the surgical risk in debilitated patients on whom major operations are contemplated, such as extensive stomach and intestinal resection for carcinoma, and to aid post-operative convalescence in debilitated patients like cases of surgical tuberculosis.

REACTION TO TRANSFUSION

The majority of patients have not experienced any noticable reaction, although a few have had some temperature and an

occasional chill. Our observations in this do not coincide with those of Lindeman, that the reaction from a blood relative in most instances is less than from an alien, *vide infra*. The immediate effect upon the patient is usually quite striking. They describe a sensation of being stimulated, and within twenty-four hours develop an enormous appetite. The feeling of stimulation persists for several days.

NUMBER OF TRANSFUSIONS

Since September 1913 the writer has made fifty-four blood transfusions by this method, the technique of which has been perfectly satisfactory. The writer has met with definite hæmolysis in two cases, and a slight reaction in a third case.

The first case was a patient with tuberculosis. A marked hæmolytic reaction existed between her blood and her husband's, but a test with the sister's blood was negative, so she was chosen as the donor. Five hundred ccm. of blood was taken from the donor, and after about 250 ccm. had been given to the recipient she suddenly complained of a peculiar feeling over her entire body and of pain low down in the spine radiating down along both sciatic nerves. The transfusion was stopped immediately without giving the remaining 250 ccm. of blood in the tube. Chills and vomiting began at once. A peculiar biuret-pink blush flushed the woman's face and body, being strikingly intense on the palms. Sweating, so profuse that droplets formed on the fingers and the palms glistened, was noted immediately. Great respiratory distress accompanied these signs, persisting somewhat longer than the characteristic blush which quickly changed to a transient cyanosis, as though the capillaries had been suddenly gorged to their absolute capacity and then had suddenly contracted to their utmost. This entire chain of symptoms occurred within three minutes of the beginning of transfusion. The vomiting and chills persisted in their full intensity for about one hour, when the temperature mounted to 101°, returning to normal within 24 hours. The vomiting continued, regardless of food (bile and mucus), at intervals of from a half to a few hours. Two hours after the transfusion bleeding began from the uterus and the small cutaneous wound in the arm, and it was uncontrollabe except by tight compression of entire arm and heavy sealing of the wound with collodion. Bleeding subsided within twelve hours.

Six hours after transfusion, a peculiar yellow color, different from, yet suggesting, jaundice made its appearance over the entire body, including the scleræ. This color disappeared in thirty-six hours. For the thirty-six hours following the transfusion there was complete suppression of urine.

One week after transfusion, an urticaria appeared over the entire body persisting for about a week and being replaced by a peeling resembling the scaling of a scarlet fever rash. Constant nausea and vomiting persisted without abatement. Patient gradually lost strength and died at the end of three weeks without evidence of any terminal infection.

The second patient showing hæmolysis was a woman of 40 having a severe secondary anæmia due to long-continued bleeding from an infected fibroid uterus, complicated by gall-stones impacted in the cystic duct. Hysterectomy was done. Two weeks later the patient experienced severe gall-stone symptoms, but was still in such an anæmic condition that removal of the stones was impossible; so blood transfusion was planned. Hæmolysis tests being negative, transfusion from her husband was attempted. After 250 ccm. of blood were given, practically the same set of symptoms as described above appeared except that the tendency to bleed was absent. The patient vomited continuously and died in twenty days.

Autopsy showed no sepsis of any sort. There were petechial hæmorrhages in the skin, scaling, and dryness. The liver was large, yellowish, and showed perilobular fatty infiltration. The kidneys showed hæmorrhagic interstitial nephritis with cloudy swelling. The spleen was bluish and somewhat large. The heart-muscle showed marked fatty degeneration with great hæmachromatosis. The marrow of the long bones was perfectly colorless, greasy and showed complete absence of blood-forming elements. The cystic duct contained four impacted stones, the gall-bladder being small and full of stones. The other organs were negative.

The third patient, a case of severe pernicious anæmia, showed only slight symptoms of hæmolysis. The main interest being in the relation of the tests to his reactions.

His first transfusion was of 600 ccm. with his son as donor (hæmolysis test negative; Rous-Turner agglutination test *positive*), from which transfusion no untoward effects were noted. One week later, after receiving 250 ccm. of blood from his daughter (tests both negative), the same symptoms of hæmolysis as described above in patient No. 1 took place immediately, but with less intensity. Instead of total suppression of urine, he had a marked hæmaturia for twenty-four hours. There was no vomiting after the first four hours. At the end of 24 hours he had completely recovered from all symptoms of hæmolysis.

One week later he received 700 ccm. of blood from son again with no untoward symptoms except violent vomiting for 15 minutes and almost immediate copious purging. Another week later, he received 600 ccm. of blood from an alien with absolutely no untoward symptoms whatsoever.

One case of profound pernicious anæmia with apparent cure eighteen months after

treatment by combined massive blood transfusion and splenectomy follows:

Patient was 45 years of age — always in good health until February, 1911. Entered hospital June, 1912, nineteen months after onset of illness. At this time her red blood count was 896,000; white count 5,000; hæmoglobin 40 per cent. Remained in hospital five months, during which time she picked up and did fairly well. When she left the hospital, September, 1912. her red count was 2,350,000; white count 7,000; hæmoglobin 55 per cent. After being home five weeks she went down again, losing fifteen pounds in one month. She entered the hospital again October 4, 1912, when the hæmoglobin was 30 per cent, reds 1,400,000, and whites 6,000, and remained in bed for six months, her condition keeping about the same. In the summer of 1913, patient was somewhat better. Then all her symptoms reappeared, and she became worse in spite of all medical treatment. January 1, 1914, the patient was extremely weak, had general œdema, dyspnœa, and her gastric symptoms became so bad that she was unable to retain even water. On January 16, 1914, she weighed only 105 pounds, the red count was 868,000; whites 3,200; hæmoglobin 25 per cent. A differential count showed polymorphs 54 per cent, large lymphocytes 17 per cent, small lymphocytes 20 per cent, transitionals 6 per cent, eosinophiles 2; basophyles 1 per cent. There were 6 normoblasts; 2 megaloblasts. The red blood corpuscles show poikilocytosis, aniscytosis, and polychromataphilia. The platelets were extremely scarce. A blood transfusion of 600 ccm. was given the same day. The following day the patient was able to eat a hearty meal. Œdema began to disappear and her general condition improved rapidly. On the day following the transfusion, the red count was 1,350,000, white count 6,000, hæmoglobin 35 per cent. One week later it was noticed that the hæmoglobin and red count were beginning to fall, so on January 24 another 600 ccm. of blood was given to the patient. The same evening the red blood count was 1,905,000, hæmoglobin 60 per cent. One week later hæmoglobin was 50 per cent, red count 1,420,000, and white count 3,200; February 10, another week later, hæmoglobin 50 per cent, red 960,000, whites 6,700. On this date another 550 ccm. of blood was given; on February 17 another 500 ccm. Three days later, hæmoglobin 65 per cent, reds 2,310,000, whites 4,450.

On this date a laporatomy was performed. On opening the abdomen considerable free fluid was found, the liver was considerably enlarged, gall-bladder enlarged and filled with black, sandy bile, pancreas was apparently normal, spleen was markedly enlarged, and appendix was bound down by adhesions. The operation consisted in removing the appendix and draining the gall-bladder. On February 24, the hæmoglobin was 50 per cent, reds 1,840,000, and whites 4,750. The patient's general condition remained about the same for four weeks when the blood began to drop rapidly, March 21, 600 ccm. of blood was given and two days later the hæmoglobin was 60 per cent, reds 2,060,000, and whites 4,000. On March 28 a splenectomy was made and 500 ccm. of blood was given to the patient at the close of the operation. The spleen measured 18 cm. x 13 cm. x 8 cm.

Spleen cut with ordinary resistance and was rather firm to pressure.

March 28, 1914: splenectomy and transfusion 500 ccm. blood. This was the last transfusion, making six in all.

April 2, 1914, blood showed hæmoglobin 55 per cent; reds 2,480,000; whites 10,000.

April 7, 1914, blood showed hæmoglobin 55 per cent; reds 2,630,000; whites 17,000.

April 12, 1914, blood showed hæmoglobin 55 per cent; reds 2,740,000; whites 17,300.

April 17, 1914, hæmoglobin 55 per cent; reds 2,770,000; whites 20,000.

April 23, 1914, discharged. Hæmoglobin 55 per cent; reds 2,820,000; whites 21,400.

Differential blood count: polymorphonuclears 55 per cent; large lymphocytes 19.5 per cent; small lymphocytes 16.5 per cent; Transitionals 3 per cent; eosinophiles 4.5 per cent; myelocyte 1.5 per cent; total 100 per cent.

February 19, 1915, patient returned for observation. Weight 186 pounds. Blood count: hæmoglobin 90 per cent; reds 5,200,000; whites 8,800.

Differential leucocytes, 100; small mononuclears, 13; large mononuclears, 11; Transitionals, 3; polymorphonuclears, 73. No abnormal cells of any sort.

The writer has performed multiple massive blood transfusion and splenectomy in five other cases of pernicious anæmia, all of which have done equally as well as this case; but wishes to observe them further before making final report.

ADVANTAGES OF METHOD

1. Known quantities of blood may be administered.

2. As much as 600 ccm. can be given in five to eight minutes.

3. Venous blood is utilized, so that arteries, such as the radial, are not destroyed.

4. Transfusion may be made without contaminating donor with blood of recipient.

5. No air comes in contact with the blood.

6. There is direct communication between vein and chamber by a simple paraffin-lined glass tube. There are no metal, rubber, or other connections, whose edges cause resistance to the flow of blood.

7. The apparatus is simple and can be made by any good glass blower.

AUTOPLASTIC REPAIR OF RECENT FRACTURES[1]

By CHARLES DAVISON, M.D., Chicago
Professor of Surgery, University of Illinois; Surgeon, Cook County and University Hospitals
AND
FRANKLIN D. SMITH, M.D., Chicago
Clinical Pathologist, University Hospital

AUTOPLASTIC bone surgery is becoming recognized as a satisfactory and dependable method of repairing skeletal defects of the human body whether congenital or the results of traumatism or disease. But in no other application are the results more promising than in the repair of a certain class of recent simple fractures of long bones which are difficult of reduction and immobilization.

The grafting across the line of fracture of fresh live bone, taken from the same individual, furnishes a method of alignment and fixation by a living, germ-resisting, osteogenic structure, which is treated kindly by the tissues and which heals in as an integral part of the body.

This method acts in sharp contrast to the use of metal plates, screws, and nails, which are foreign bodies, always producing a certain amount of pressure necrosis, absorption, and disintegration of tissue. The foreign body depresses the local resistance and activity of the tissues while lowering of vitality always favors infection. Foreign bodies are resented by the tissues and at the best are only tolerated and encysted. The foreign body invites infection. The bone graft resists infection. The bone graft, in its sphere of usefulness, will eventually eliminate the Lane plate in the repair of recent fractures.

INDICATIONS FOR THE USE OF THE TRANSPLANT

The indication for the use of the transplant in a certain group of recent simple fractures is clear and decisive. Simple fractures may be divided for clinical purposes into three groups:

1. Those fractures in which good functional and anatomical end-results can be attained by external reduction and external immobilization. Open operation of any kind is contraindicated in this very large group of fractures.

2. Those fractures in which it is necessary to expose the fracture by incision to effect proper reduction, but which, when once reduced, can be securely and safely immobilized by external methods.

3. Those fractures in which it is necessary to expose the fracture by incision to effect proper reduction, and which require both internal alignment and fixation and external immobilization to secure satisfactory end-results.

Autoplastic repair is indicated in the third group of fractures.

METHODS OF APPLICATION

There are two practical methods of application of the transplant in the autoplastic repair of these fractures, depending upon the location of the bone lesion.

I. A splint of living bone without periosteum from the same individual is applied in the medullary canal across the line of fracture to establish reduction and alignment and to maintain a certain amount of fixation of the fragments, when the fracture is located in the shaft of a long bone which contains a natural cavity extending above and below the point of injury.

The transplant maintains the reduction, lives, and grafts to the compact bone of the fragments under the following conditions:

1. An aseptic operative wound.

2. A live transplant from the same individual, free from periosteum. Periosteum is a fibrous tissue and when retained on transplanted bone, buried in bone, prevents grafting to the extent of its interposition.

3. Actual contact between the splint and the compact bone of each fragment.

4. External immobilization of the fragments, so that there is no movement between

[1] Read before the Chicago Surgical Society, May 7, 1915.

Fig. 1. Fig. 2. Fig. 3.

Fig. 1. Case 1. Röntgenogram of spiral fracture of the shaft of the humerus.

Fig. 2. Case 1. Röntgenogram of humerus, two months after operation, showing the transplant grafted to the fragments and bony union between the fragments

Fig. 3. Case 1. Röntgenogram of humerus, fourteen months after operation, showing partial absorption of the transplant, especially at the lower end.

the transplant and its host. The graft becomes a living, integral portion of the repaired bone, taking its part in the functional support of the extremity.

II. A peg of living bone is inserted across the line of fracture, through the cancellous bone and anchored to the compact cortical bone at either end, when the interior is composed of spongy, cancellous bone instead of a medullary cavity.

The peg maintains the reduction, lives, and grafts to the surrounding bone under the same conditions required by the transplant when in the medullary canal. The ends of the peg graft directly to the compact cortical bone at the points of contact. That part of the peg which is buried in cancellous bone stimulates the production of osteoblasts and the growth of new-bone which spreads from the transplant and infiltrates the spongy bone around the peg until they merge in a continuous bony mass across the line of fracture. This new-bone increases in solidity and strength according to the functional demands put upon it, taking its part in the support of the extremity, later to be modified and absorbed as the necessity of support lessens.

THE FATE OF THE MEDULLARY TRANSPLANT[1]

Occasional early absorption. Absorption of the transplant soon after transplantation occasionally occurs. In such a delicate process as the transplantation of living tissue, absorption may be dependent upon many factors; i.e., the employment of protoplasmic poisons, during the operation, as bichloride of mercury, etc. However, a small percentage of absorptions are due to formation of specific ferments against the foreign tissue proteid, which promotes rapid autolysis and absorption.

Early changes in the tissues between the host and the transplant. Any space between the transplant and the bone of the host is immediately filled in with coagulated blood and lymph which undergoes organization into osteoid material. At the same time small capillaries are seen to push through this new-

[1] From the laboratory of Clinical Pathology of University Hospital.

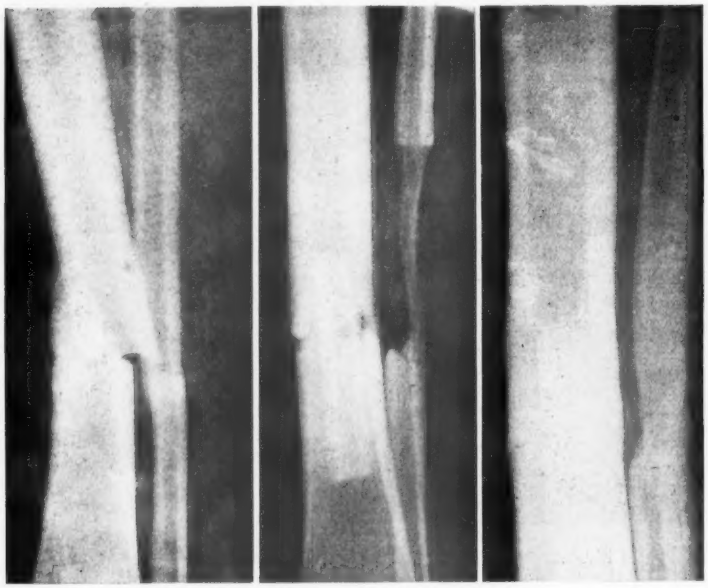

Fig. 4. Fig. 5. Fig. 6.

Fig. 4. Case 2. Fracture of tibia and fibula.

Fig. 5. Case 2. Röntgenogram of tibia and fibula, two months after operation, showing the fibular transplant in the tibia grafted to the fragments and beginning regeneration of bone at the defect in the fibula.

Fig. 6. Case 2. Röntgenogram of tibia and fibula, seven months after operation, showing complete bony repair of the fracture in the tibia with beginning absorption of the transplant and solid bony regeneration at the defect in the fibula.

formed tissue from the compact bone of the host to the compact bone of the transplant forming a vascular network about the transplant. Later fine capillaries from this network around the transplant are seen to push themselves into the empty haversian canals of the graft. Both ends of the transplant are sealed off from the distal and proximal marrow cavities by a clot. The surface of these clots at the ends of the transplant are covered over with a layer of endosteal cells from the proliferation of the endosteum of the host.

The surface of the clot is concave, the edges extending up the sides of the bone of the host. The end clots are finally transformed into osteoid tissue and later become calcified. In the case of a fibula-transplant, the osteoid material forms a plug extending into the medullary cavity of the transplant. The transplant first becomes firmly fixed at its ends in about thirty days.

Death of the bone-cells. Many bone-cells in the periphery of the graft retain their vitality; but of those situated in the center of the transplant, only a few are capable of keeping intact the calcium saturated matrix. When a bone-cell dies, the matrix under its influence must be removed and new bone laid down in its place. In the transplant bone-cells are seen in all stages of destruction and development.

Reëstablishment of a permanent circulation. Newly formed capillaries are seen entering the haversian canals of the transplant. They are derived from the fine capillary network formed about the graft. These fine capillaries do not always pass through the graft by way of the haversian canals but are seen passing into the transplant wherever it is possible to gain an entrance. In a fibula-transplant, the capillaries pass through the compact bone and ramify in the marrow substance which has been transplanted with the

Fig. 7. Case 3. Röntgenogram of fracture of anatomical neck of humerus.

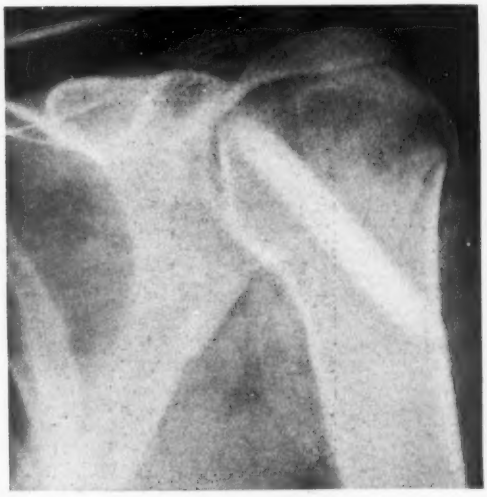

Fig. 8. Case 3. Röntgenogram of head of the humerus five weeks after operation, showing the transplant grafted to the fragments and union of the fracture.

fibula. Numerous large cells constantly accompany the blood-vessels and are maturing bone-cells. The reëstablishment of the permanent circulation is absolutely necessary for the future success of the transplant.

Methods of new-bone formation. Necrotic bone may be replaced by the familiar method of lacunar absorption followed by deposition of bone; layer after layer of bone may be replaced by direct continuity. The mature bone-cell has either the property of producing bone absorption or the ability to build new bone.

The entire transplant is changed into a complete osseous entity. After many months, the transplant becomes directly continuous with the adjacent tissues of the host. The organized tissue undergoes a trabecular stage of bone formation, and finally the space it occupies is filled by compact bone. The time necessary for such a complete transformation varies with the size of the graft, the condition and age of the host, and will vary from one to two years.

Final absorption of the transplant. A medullary transplant is not a permanent entity, since a decrease in functional demand is always associated with atrophy and absorption. As the permanent callus fills the functional demand, the absorption of the osseous splint increases until eventually the transplant is completely absorbed. Total absorption of the transplant placed into the medullary cavity of the humerus will be accomplished in two to five years depending upon its size, the functional result, and the age of the patient.

The fate of the transplant placed into cancellous bone. The changes in the compact bone of the transplant are the same as those in any other osseous transplant. However, the changes in the cancellous bone, immediately adjacent to the graft, are important. New trabeculæ of bone are formed which are directly continuous with the compact bone of the transplant. The new trabeculæ extend out between the trabeculæ of the cancellous tissue, finally producing a more compact osseous structure. Where the area of cancellous tissue between the compact bone of the transplant and the compact bone of the host is small, as in experimental animals (head of humerus in a rabbit), the entire area becomes transformed into compact bone. However, this structure is not permanent since there is no physiological function which demands

Fig. 9. Case 4. Röntgenogram of comminuted fracture of anatomical neck and tuberosities of the humerus.

Fig. 11. Case 4. Röntgenogram of head of humerus, fourteen months after operation, showing extensive absorption of the deposit of new-bone and beginning absorption of the transplant.

Fig. 10. Case 4. Röntgenogram of head of humerus, eight months after operation, showing bony union of the fracture and the transplant grafted in position across the fracture with deposit of new bone around it.

compact osseous tissue in this region. With a favorable functional result the recently produced compact bone together with the transplant will eventually undergo absorption since a decrease in functional demand is associated with a corresponding atrophy (disuse atrophy) and absorption.

EXHIBITION OF PATIENTS WITH SERIAL RÖNTGENOGRAMS

CASE 1. Fracture of shaft of humerus. O. S., American, clerk, age 37, was admitted to Cook County Hospital after injury to arm caused by falling from a porch, while intoxicated. Examination showed a healthy appearing man with slight physical development and with an injury to his left arm, accompanied by abnormal mobility, angular deformity, and shortening. Röntgenoscopy revealed a spiral fracture of the shaft of the humerus with slight comminution. The spiral defect was 7 cm. long and the fragments overlapped 3 cm. Reduction and immobilization by external means was not successful (Fig. 1).

Operation for the autoplastic splinting of the fragment was done February 10, 1914. A transplant was taken from the crest of the tibia 13 cm. long and 12 mm. thick in each direction. It was inserted into the medullary canal of the humerus across the defect caused by the fracture, each end projecting into the corresponding fragment about

Fig. 12. Case 5. Röntgenogram of fracture of the neck of the femur.

Fig. 13. Case 5. Röntgenogram of neck of femur, four months after operation, showing bony union of the fracture and grafting of fibular transplant across the line of union.

25 mm., to give support and stability to the repair. The wound was closed by layer sutures, covered with abundant sterile dressings, and the extremity carefully immobilized to the body by plaster of Paris to prevent change in alignment.

Bony union with a palpable callus, a perfect bone line, and a functional arm was present at the end of four weeks. The arm was protected two weeks longer. A röntgenogram taken two months after operation shows bony repair of the fracture with slight external callus, and the transplant grafted to the fragment across the line of fracture (Fig. 2). A röntgenogram taken fourteen months after operation shows partial absorption of the transplant. The lower portion of the graft has undergone much more absorption than the upper part, opposite the comminution of the fracture, where the functional demands for support were greater and lasted longer (Fig. 3). Good anatomical and functional recovery resulted.

Case 2. Fracture of tibia and fibula. F. M., Irish, school boy, age 14, was admitted to the University Hospital September 21, 1914, with his left leg in a plaster cast. He was injured in a runaway by collision with a telegraph pole three weeks previous to admission and was taken to Cook County Hospital, where three unsuccessful efforts at reduction, under ether anæsthesia, were made.

Examination showed a healthy, vigorous boy, with his left leg in a cast. Röntgenoscopy revealed fractures of both bones in the lower third of the leg, with the fragments out of alignment (Fig. 4).

Operation for reduction and autoplastic bone-splinting of the fragments of the tibia was done two days later. The fracture in the tibia was exposed by direct incision and the position and condition of the fragments examined. Another incision on the outside of the leg exposed the fracture in the fibula. A section of the upper fragment of the fibula 6 cm. in length was removed without the periosteum for a bone splint.

The oval shape of the fibula at this section corresponded very closely to the shape and size of the medullary canal of the tibia and, when fitted and introduced as a splint, locked the fragments of the tibia together in a very firm and substantial manner. The wound was closed by layer sutures and covered by a gauze and plaster dressing.

A röntgenogram taken two months after the operation shows good alignment of the fragments of the tibia, grafting of the transplant across the line of fracture, and beginning regeneration of bone at the defect in the fibula. The ends of the medullary canal in the transplant are sealed by new bone (Fig. 5). A röntgenogram taken seven months after operation shows complete repair at the line of fracture in the tibia, with beginning absorption of the transplant, especially at the lower end, and reëstablishment of the medullary canal of the tibia through that of the transplant. Regeneration at the defect in the fibula exhibits a solid bony replacement in which a new medullary canal is beginning to appear where previous röntgenograms showed earliest efforts at regeneration (Fig. 6).

Good anatomical and functional recovery resulted.

Case 3. Fracture of the anatomical neck of the humerus. J. B., American, teamster, age 42, was admitted to Cook County Hospital, one day after he was struck by an automobile. Examination

Fig. 14. Osseous transplant into the cancellous structure of the femur (human), twenty-three days after transplantation. New-formed bony trabeculæ continuous with the transplant.

showed a man with the symptoms of fractures of the upper end of the left humerus. Röntgenoscopy revealed a fracture through the anatomical neck of the humerus (Fig. 7).

Operation for autoplastic repair of the fracture was done ten days later. Incision over the fracture showed that the small fragment was rotated so that the surfaces of the fracture were not in apposition in any part. A canal was made in the cancellous bone in the upper fragment for the reception of one end of the autoplastic peg, and a notch was cut on the medullary wall of the compact bone of the lower fragment to hold the lower end of the peg. A peg without its periosteum was taken from the spine of the tibia, by caliper measurements, to fit the space prepared for it in the fragments. The peg was driven into the canal in the small fragment and the other end adjusted in the notch in the lower fragment. While the wound was open and the repair in full view, the forearm and elbow were fastened to the trunk by strips of adhesive plaster to retain by immobilization the position of rotation of the fragments. The wound was closed by catgut sutures in layers, dressed with sterile gauze, and the extremity secured to the trunk by plaster of Paris for four weeks. Röntgenogram five weeks after operation shows good position of the fragments with bony union, and transplant grafted to the surrounding bone (Fig. 8).

The patient recovered with full functional use of the shoulder-joint.

Case 4. Fracture of the anatomical neck of the humerus with comminution of the tuberosities. J. T., Irish, marine cook, age 49, was admitted to Cook County Hospital, March 3, 1914, suffering from an injury to the left shoulder produced by falling down a stairway while intoxicated.

Examination showed an elderly dissipated man, with left shoulder severely bruised, with pain and crepitus on manipulation of the shoulder. Röntgenoscopy showed a fracture of the anatomical neck of the humerus with comminution of the tuberosities and outward displacement of the head of the humerus (Fig. 9).

Open operation was done five days later. Incision over the injury showed the tuberosities crushed and slivered into many small pieces and widely separated. The head was displaced outward and the joint was open.

An autoplastic bone peg 5 cm. long and 15 mm. thick and wide, without its periosteum, taken from the crest of the tibia, was embedded in the cancellous bone underneath the cartilage of the head of the humerus and the other end of the peg secured in the medullary canal of the lower fragment, the peg holding the head of the humerus like the handle of an umbrella. The fragments that remained attached to the periosteum or cartilage were placed around the peg, the wound closed, and arm immobilized to the trunk in a plaster dressing.

Three weeks after operation the dressings were removed and union appeared to be firm. Manipulation of the arm showed that the head and shaft of the humerus moved together during rotation and other movements of the arm. He left the hospital in another week with good use of arm and shoulder.

A röntgenogram taken eight months after the autoplastic fixation shows the head of the humerus in position in the glenoid cavity; bony union of the fracture; considerable ragged callus not encroaching upon the joint; the autoplastic peg intact in position across the healed line of fracture, grafted into the bone and forming an integral part of it with its edges blending into the recipient bone in every direction. The cancellous tissue of the head of the humerus appears infiltrated with new-bone of the same type as the transplant from which it was generated (Fig. 10). A röntgenogram taken fourteen months after operation shows extensive absorption of the new-bone formation in the head of the humerus and beginning absorption of the transplant (Fig. 11).

A very mobile shoulder-joint resulted.

Case 5. Fracture of the neck of the femur. A. D., Irish, laborer, age 63, alcoholic, slipped on the ice and injured his left hip. He was admitted to Cook County Hospital at once, February 2, 1915.

Examination showed an old man with a painful hip, a helpless lower extremity in abduction and eversion of the foot. There was 3 cm. shortening on the injured side. Röntgenoscopy showed a fracture of the neck of the left femur (Fig. 12).

Operation for autoplastic repair of the fracture was done four days later under ether-oxygen anæsthesia. The patient was secured to a Hawley fracture table with both thighs strongly abducted and with

Fig. 15. Medullary transplant into the femur of a rabbit, six months and two weeks after transplantation. Complete metamorphosis of transplant into an osseous entity, showing haversian canals entirely surrounded by lamellæ of osseous deposition.

Fig. 16. Medullary transplant into the femur of a rabbit, seven weeks after transplantation. Osseous trabeculæ filling in the space between the transplant and the cortical bone of the host. Transplant on the left; cortical bone on the right; osseous trabeculæ in the center.

slight traction. An incision was made over the greater trochanter and extended downward along the shaft of the femur a sufficient distance to obtain access to the field of the fracture. The line of fracture was exposed by lateral dissection and retraction of the soft parts. The table, with the extremity fixed to it, was adjusted until reduction of the fragments was complete. A point on the shaft of the femur below the greater trochanter which would give the proper angle for insertion of the peg was selected, and a canal was cut with a reamer upward and inward, across the line of fracture, through the cancellous structure of the neck, into the head of the bone.

An autoplastic peg was taken from the lower part of the fibula of the same extremity. A segment of the whole thickness of the bone, without periosteum, 11 cm. long, was used. The opening in the shaft of the femur was accurately fitted to the irregularities of the larger end, so that the femur would not split when the transplant was driven through or the peg rotate when in position. The peg with the small end first was driven snugly into the canal. The abducted thigh was placed in extreme external rotation to relax the muscles attached to the great trochanter.

The wounds were closed with layer catgut sutures and dressed with sterile gauze. The hip-joint was immobilized by a body plaster-of-Paris cast extending to the axilla, to the toes on the injured extremity and including the opposite thigh.

A röntgenogram four months after operation shows bony union of fracture with abundant callus (Fig. 13).

In the autoplastic treatment of fractures of the neck of the femur, three points are of importance:

1. Use of a section of fibula for transplant.
2. Introduction of the transplant at a high angle to limit cross-breaking strain, when possible an angle with the shaft of the femur of 135 degrees.
3. Complete immobilization in a position to neutralize muscular action.

CONCLUSIONS

1. Autoplastic treatment of recent simple fractures is indicated where non-operative methods are inefficient.
2. The transplant, in the medullary canal, in recent fractures of the shaft of long bones, supports the line of fracture, lives and grafts to the compact bone of the fragments.
3. The transplant in cancellous tissue, when supported by contact to compact bone, grafts to the compact bone and infiltrates the spongy bone with new-bone, supporting the line of fracture.
4. The transplant eventually undergoes modification and absorption as functional demand for support at line of fracture ceases.

DEPARTMENT OF TECHNIQUE

THE EFFICIENCY OF THE COOLIDGE X-RAY TUBE AND THE RATIONALE OF RADIOTHERAPY IN THE TREATMENT OF MALIGNANT TUMORS [1]

By ISAAC LEVIN, M.D., NEW YORK.
From the Department of Cancer Research of the Montefiore Home and Hospital

PHYSICAL PROPERTIES OF ACTINIC RAYS

IT is indispensable to have at least a rudimentary knowledge of the physical properties of the actinic rays in order to understand the requirements for a correct biological and consequently therapeutic utilization of these rays. Actinic rays, i.e., rays emitted by a röntgen tube or by radio-active substances, are in many respects analogous to the rays of light. They move in straight lines, they traverse space without any obvious transference or intervention of matter, they act on a photographic plate, excite certain materials to phosphorescence, and bring about the ionization of gas. The only characteristic of light which actinic rays do not possess is the deflection by prisms or lenses. But very recent investigations have shown that such a deflection may be obtained when crystals are used instead of mirrors or prisms. If a pencil of röntgen rays is made to traverse a crystal, diffracted pencils are formed, arranged about the primary beam in a regular pattern, according to the structure of the crystal. A photographic plate placed perpendicular to the primary rays and behind the crystal would show a strong central spot where the primary rays struck it, and other spots arranged in regular fashion around the central spot in the places struck by the diffracted pencils (Figure 15, from *X-rays and Crystal Structure* [1], shows such photographs).

Thus it seems quite reasonable to suppose that the rays of light and the actinic rays are qualitatively identical. The difference between the two kinds of rays consists in the fact that the waves of ether forming the actinic rays are considerably shorter than the shortest ultraviolet waves of light. The waves of the so-called soft röntgen rays are about one thousand times shorter than those of ultraviolet light, and the waves of the hard röntgen rays are still shorter. The truth of this assumption is further enhanced by the fact that the photographs shown in Fig. 15 were calculated mathematically before they were proved by experiment.

All substances, when exposed to a beam of röntgen rays, absorb a part of the rays. The fraction of the rays thus absorbed depends upon the density and thickness and the atomic weight of the substance. The remaining rays penetrate beyond the interposed substance. Besides this, the primary röntgen rays produce in the substance the formation of secondary cathode rays; i.e., swiftly moving electrons and also secondary röntgen rays. Figure 16 gives a rough symbolic sketch of the production of secondary cathode and X-rays in matter exposed to primary X-rays. In accordance with the modern conception of the structure of matter an atom consists of a large nucleus charged with positive electricity, surrounded, like a planet by satellites, by two circles of negatively charged electrons. An electron is the smallest unit of matter known today and is at the same time apparently an independent unit of electricity; in other words, it is something which links together matter and energy. The minute spaces between the atoms contain the hypothetical ether, which is supposed to penetrate all space in nature. When a wave of ether is short enough to penetrate between the atoms (i.e., hard röntgen rays), it sets in rapid motion a certain number of electrons and thus creates secondary cathode rays. The rapidly moving electrons, on the other hand, create new waves in ether situated between the atoms; i.e., create secondary röntgen rays. Very recently Rutherford showed that the Γ-rays emitted by radium may be regarded as secondary röntgen rays produced in the radium by the action of B-particles; i.e., electrons. Figure 16 shows graphically the relationship in space between the cathode rays or electrons of the cathode

[1] Read at the meeting of the Surgical Section of the New York Academy of Medicine, May 7, 1915.

Fig. 1. A case of ulcus rodens treated by radium.

of an X-ray tube, the primary X-rays, the positively charged nucleus of an atom, the two circles of electrons surrounding the atom of matter, the free electrons between the atoms; i.e., the secondary cathode rays, and the secondary X-rays. The characteristics of the secondary röntgen rays depend solely upon the velocity of the primary cathode rays and the atomic structure of the substance exposed to the primary röntgen rays. The character of the secondary X-rays will be the same, for instance, whether the primary X-rays penetrate a certain metal or a solution of a salt of the same metal. This conception of the structure of matter and the nature of the actinic rays makes clear the importance of the three main characteristics of the rays; namely, the *penetration*, the *absorption*, and the *selective action*. Hardest X- or Γ-rays, i.e., shortest waves of ether, penetrate between the atoms of matter without affecting the substance in any manner. Soft rays, i.e., longer waves of ether, are unable to penetrate between the atoms of the substance and are dispersed over the surface of the substance and again produce no effect on the latter. Only when the relationship between the atomic structure of the substance and the wave length of the X-rays is correct does there take place a *selective absorption* of the rays by the substance, and the latter is then influenced by the rays.

Fig. 2. Radiograph of the chest of Case 3. Left clavicle shows destruction of bone due to a metastasis of carcinoma.

THE RELATIVE EFFICIENCY OF THE BIOLOGICAL ACTION OF THE RÖNTGEN RAYS EMITTED BY THE COOLIDGE AND THE OLD-TYPE TUBES

When a plant or animal body is exposed to the action of röntgen or Γ-rays there undoubtedly take place the same atomic disturbances in the cells of the body as in a piece of metal or any other unorganized substance. As a consequence the rays injure the protoplasm, or more frequently the nuclei of the cells. This biological action differs quantitatively in accordance with the amount and character of the rays absorbed by the cells and the specific susceptibility of the latter to the action of the rays. When slightly injured the cell may completely recover, while if the injury is severe the cell dies. All the tissues of the organism may be killed by a sufficiently large quantity of rays. Nevertheless the biological action of the röntgen rays must be considered *selective*, inasmuch as quantities of the rays sufficient to kill a certain kind of tissue may leave adjacent tissues intact or only slightly injured. In order to obtain this selective action the rays must be distributed as evenly as possible through the organism, so that only a comparatively small

Fig. 3. Microscopic specimen of epithelioma of the vagina before radiation.

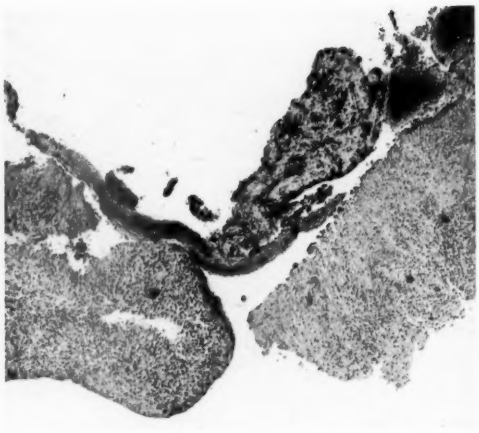

Fig. 4. Microscopic specimen of the vagina after radiation. Connective-tissue and round-cell infiltration. No evidence of carcinoma.

quantity of the rays will reach each individual cell. On the other hand, a sufficiently large fraction of the rays must reach as far as possible from the surface of the body. Such a distribution is possible only with the hard rays, whose penetration is much greater than their absorption.

At present there does not exist a direct method for measuring the quantity and the penetration of the rays necessary to produce a certain biological effect. All the measurements are indirect and are based on the fact that the various chemical actions of the rays are also in direct ratio to their quantity. A solution of barium-platincyanide, which has normally a green color, becomes brown under the influence of the rays, and the shade depends upon the quantity of the rays used. A strip of photographic film wrapped in black paper and consequently impermeable to the rays of light will become darkened under the influence of the röntgen rays. The shade of

Fig. 5. Gross specimen of carcinoma of the sigmoid. The lower part of the photograph shows the tumor covered with the fibrous mass and the skin above it. The upper part shows the colostomy opening of the sigmoid.

Fig. 6. Gross specimen of a loop of small intestines studded with minute metastatic nodules.

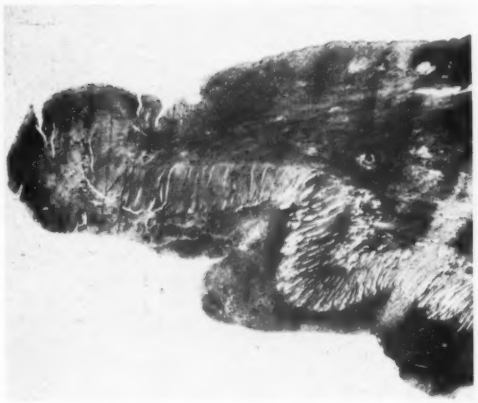

Fig. 7. A microscopic section through the sigmoid tumor. Shows, beginning from the top of the photograph, skin, dense connective tissue, musculature, and carcinoma replacing the mucous membrane. (Low power.)

darkening of the strip depends on the quantity of rays used. On the basis of these color reactions, various apparatus are devised for measuring the quantities of the röntgen rays emitted by a tube in a unit of time.

Before reporting the results of the present experimental study on the relative therapeutic efficiency of the Coolidge and old-type X-ray tubes, a brief outline must be given of the differences in the physical characteristics of the two types of tubes.

Röntgen rays originate on the surface of a metal which is bombarded by the negative electrons of the cathode rays. The greater the velocity of the cathode rays the harder, the more penetrating, are the röntgen rays. The tubes of the old type have an incomplete vacuum. A high-potential current passes in the tube from the anode to the cathode, frees the electrons of the latter, and propels them toward the anticathode or target. The bombarding of the electrons induces the formation of the röntgen rays on the surface of the target. The target is built of a heavy metal and becomes overheated under the action of the cathode rays. The heat frees the gases contained in the metal of the target, and these in turn diminish the vacuum of the tube. As a consequence the velocity of the cathode rays also diminishes and the röntgen rays become softer. Various regulating devices are added to the tube in order to keep the character of the röntgen rays uniformly hard for the length of time necessary for therapeutic purposes. Still the penetration of the rays emitted by the

Fig. 8. Microscopic section of the connective tissue surrounding the sigmoid tumor. There are scattered islands of degenerated carcinoma-cells (the black dots).

tube constantly changes. The old-type tube used in the present study is the one devised by Gauss (2), of Freiburg, for therapy. It has a water-cooling chamber to diminish the heating of the target, a large auxiliary vacuum bulb to diminish the influence of the gases freed from the overheated target on the combined vacuum, and a gas regulator to increase the amount of gas in the bulbs and diminish the vacuum when it becomes too high, and consequently no X-rays can be formed. This Gauss tube is by far superior to any other of the ordinary old-type gas tubes. Therefore, as will be shown later, the difference between the Gauss and Coolidge tubes found in the present study, though very marked, is not as great as the one found by L. G. Cole (3) in his experiments.

The fundamental advantage of the Coolidge tube consists in the fact that it has nearly a complete vacuum, so that the small amount of gas escaping from a heated target cannot influence it. Moreover, the target is built of tungsten,

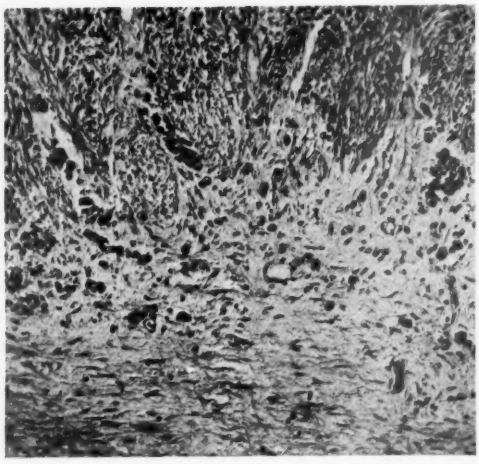

Fig. 9. A microscopic section of a peritoneal metastatic nodule of carcinoma. The upper part of the photograph shows musculature of the intestinal wall; the lower, dense connective tissue. The islands of black spots represent tumor-islands.

which is completely freed of gas before the tube is built. In such a tube with a very complete vacuum a high-potential current cannot pass from the anode to the cathode and free the negative electrons of the latter. The freeing of the cathode rays is accomplished in the Coolidge tube through the heating of the cathode to a very high temperature by the aid of a special storage battery. The cathode consists of a spiral tungsten filament supported by a molybdenum sleeve. The high-potential current propels the electrons to the anode, which acts at the same time as a target. The number of the electrons depends upon the temperature of the filament of the cathode and their velocity on the voltage of the primary current. Figure 17 shows the diagrams of the two tubes used.

A priori it could be expected that the Coolidge tube would not only produce a greater output of röntgen rays, but also would generate rays of greater uniformity of penetration. Comparative experiments were done, as was stated above, with the Gauss and the Coolidge tubes, using a very heavy German coil as a generator. Both tubes were placed approximately under similar conditions; i.e., the same voltage of primary current was sent through the coil, nearly the same number of milliamperes of high-potential current were sent through the tube, and the resulting röntgen rays showed the same penetrating power.

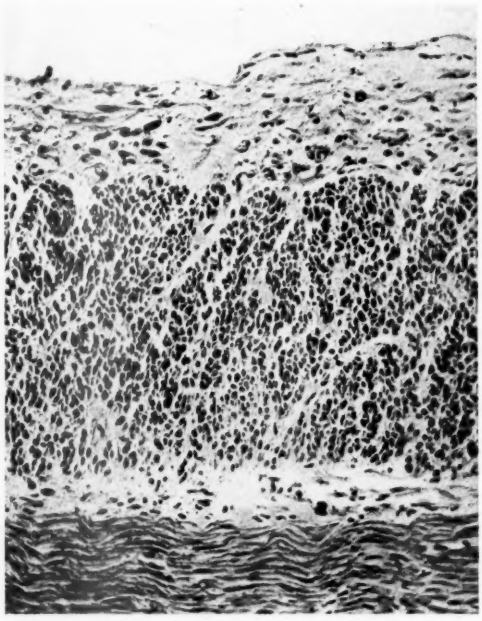

Fig. 10. A microscopic section of the wall of the small intestines. The upper margin of the photograph shows normal peritoneal endothelium unaffected by the radiation.

To study the distribution of the rays, pieces of meat of certain thickness and also living animals (pigeons) were radiated. Test strips of photographic paper (Kienböck strips) were placed on the surface of the radiated piece and at various depths of tissue. Pieces of meat were used 1, 1.5, 2, 3, and 4 inches in thickness. The very soft rays, which usually act only on the surface of the skin of the animal and are not selective but caustic in their action, were absorbed by a plate of aluminum 3 mm. in thickness and a layer of chamois leather 2 mm. thick placed between the tube and the tissue. This filtration was selected as being identical with the filtration used by the writer in his clinical work. The pigeons were placed in a box 4 inches deep. One Kienböck strip was placed over the box and the other under the box. Figure 18 shows the records of two experiments: *a*, an experiment with 4 inches of meat and a Gauss tube; *b*, an experiment with 4 inches of meat and a Coolidge tube; *c* shows the Kienböck quantimeter and the method of estimation.

The results of numerous experiments may be summarized as follows:

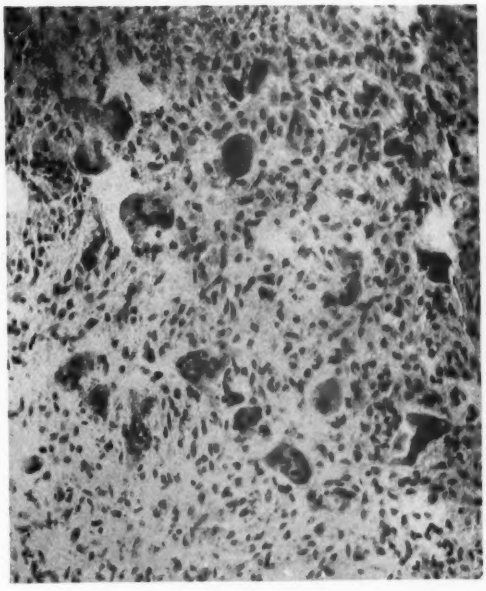

Fig. 11. Microscopic section from tumor of Case 8 before treatment. Shows sarcoma with numerous giant cells.

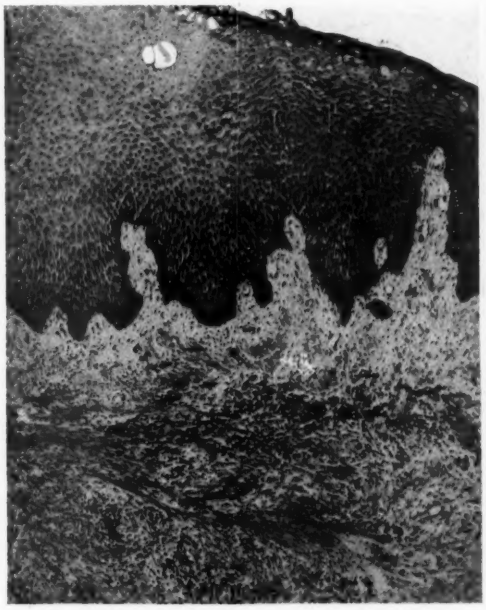

Fig. 12. Microscopic section from tumor of Case 8 after treatment. Shows connective tissue, no tumor-cells.

To obtain the same quantity of rays on the surface with a Coolidge tube takes about one-third of the time that was required with the old-type tubes. At the depth of 2 inches of meat the strip shows about one-third the quantity of the rays shown by the surface strip during the same experiment with an old-type tube and about one-half by the Coolidge tube. At a depth of 4 inches there is usually about one-seventh of the quantity shown on the surface obtained from a Gauss type, while from a Coolidge tube one obtains at the same depth usually one-fifth of the quantity shown on the surface. There is no complete regularity in the results of the experiments with either tube, but the Coolidge tube shows a far greater uniformity. The reason for this superiority shown by the Coolidge tube is probably due to the following: The röntgen rays emitted by a tube are never uniform in their character and represent all grades of hardness. The methods of measuring the penetration of the tube reveal only the hardest rays. Apparently the rays are more uniform in the Coolidge tube and a greater proportion of the pencil of rays are of the hardest quality, and therefore a higher fraction of those entering the surface reach a certain depth. Another great advantage of the Coolidge tube consists in the fact that when it is once regulated to a certain penetration it remains so for an indefinite period of time. On the other hand, it must not be presumed that the rays of the Coolidge tube have an unlimited capacity of absolute penetration. As stated above, the velocity of the cathode rays and the consequent penetration of the röntgen rays is in direct proportion to the intensity of the high-potential current. The latter cannot be increased beyond a certain limit in the Coolidge tube as it is constructed today. But, as stated above, the most recent investigations on the nature of the secondary röntgen rays, as well as the constant improvements in the construction of the generating machines and tubes, leave no doubt that the near future will show a great deal of further progress in the efficiency of the therapeutic action of the röntgen rays.

RESULTS OF THE TREATMENT OF MALIGNANT TUMORS BY RADIUM AND RÖNTGEN RAYS

As stated above, the susceptibility to the action of the actinic rays varies in degree with the cells of the different tissues. The cells of malignant tumors are more susceptible to the action

Fig. 13. Radiograph of Case 8 before treatment. Shows tumor of the lower jaw with two radium tubes *in situ*.

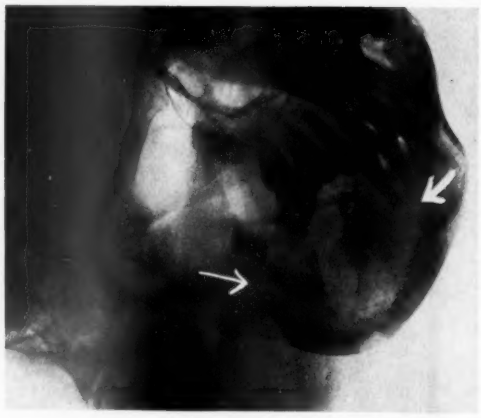

Fig. 14. Radiograph of Case 8 after treatment. The arrows show the new bone formation.

of the rays than the cells of normal tissues surrounding the tumor. If the rays employed are of a correct quality and in a sufficient quantity it is possible to destroy all the cancer-cells in a certain locality and at the same time leave the normal tissues either intact or so slightly injured that they ultimately completely recover.

The best proof of this assertion can be seen in the results of the treatment of ulcus rodens by radium. The writer treated several cases in which the ulcer was smaller than the tube of radium employed. Figure 1 shows the result of treatment of such a case of ulcus rodens of the nose. Only a part of the tube covered the ulcer, the rest of the tube lying just as closely to the normal skin. The normal skin was not injured or even irritated in any degree, while the ulcer was healed. This indicates sufficiently well that the radium employed with the modern technique does not act as a simple caustic, but has a selective action on the tumor-cells.

This quantitatively selective action of the rays may reach to a depth of at least 3.5 cm. Bumm and Warnekros (4) and Wickham and Degrais (5) state that it is even possible, with the modern methods of röntgen or radium therapy, to destroy cancer-tissue at a depth of 9 to 10 cm. The action of the rays on a malignant growth consists primarily in the destruction of the tumor-cells and subsequently the formation of sclerotic connective tissue which compresses and destroys the remaining tumor-cells.

It is as yet difficult to obtain a true valuation of the significance of radiotherapy in the treatment of malignant tumors. The modern correct methods have been in use less than three years, and the majority of cases in which it is employed are the most advanced forms of the disease. Nevertheless, as will be seen later, some of the results obtained are very significant and promising. Excluding epitheliomata of the skin and cases in which treatment began too recently for a correct analysis, the writer treated, during the last eighteen months, 41 cases of deep-seated malignant tumors with the modern methods of radium and röntgen therapy. The conditions were distributed as follows:

Carcinoma of the breast	9
Carcinoma of the mouth	6
Carcinoma of the larynx	1
Carcinoma of the œsophagus	3
Carcinoma of the uterus and vagina	7
Carcinoma of the ovary	1
Carcinoma of the urinary bladder	1
Carcinoma of the stomach	4
Carcinoma of the sigmoid and rectum	5
Sarcoma	4

Of these cases, 13 died, 11 discontinued treatment, 14 remained unimproved, and 3 seem to be at present clinically cured. At first glance these results do not seem to be gratifying, the more so that even the clinically cured cases, which represent 7.5 per cent of all cases treated, have not been observed long enough to give any certainty as to the permanency of the results. On the other hand, considering the hopelessness of the class of cases that came under treatment, the results are by far superior to anything which

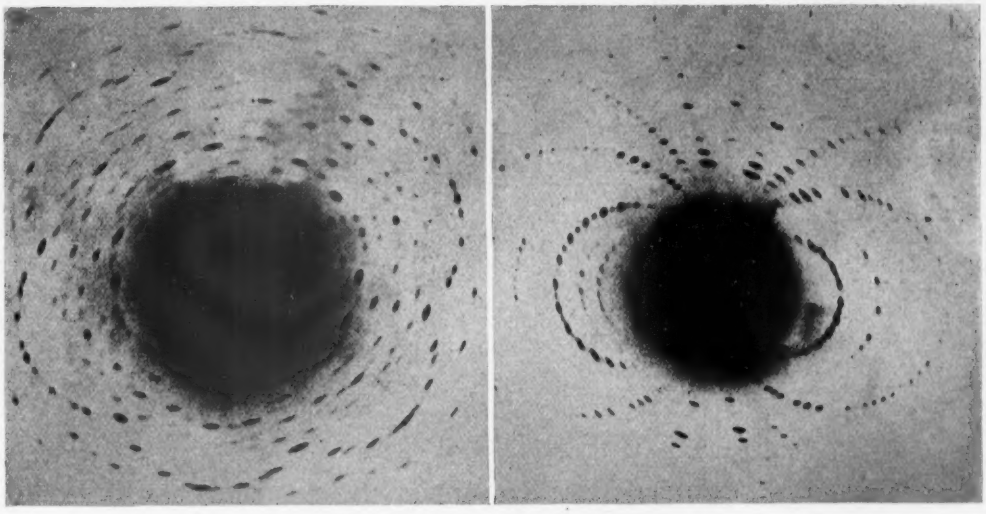

Fig. 15. Photographs of a pencil of röntgen rays passed through a crystal, beryl left, nickel sulphate right.

was attempted with this class of cases previously. Moreover, in several cases which did not improve clinically under treatment, morphological changes were noted in the tumors which strikingly indicate the value of radiotherapy in the treatment of malignant tumors, when the class of cases, the time, and the method of treatment are selected correctly. The histories of a few selected cases will illustrate these points:

CASE 1. Mrs. Br., age 39. A radical amputation of the right breast for carcinoma was done on November 17, 1913. The axillary and the supraclavicular glands were involved and all the malignant tissue could not be removed. The supraclavicular and axillary region were treated with radium and the other regions of the right side of the chest with röntgen rays. In the subsequent course of the disease there developed carcinoma in the other breast and metastases in both femurs and internal organs. The patient died nine months after the operation. The right side of the chest, which was radiated, did not show any local recurrence all through these months.

It is frequently noticed, in recurrent carcinoma of the breast treated by the rays, that while the patient may die from the metastases in the internal organs, the chest-walls remain free of the tumor. The psychic effect of the phenomenon upon the patient is very gratifying.

CASE 2. Mrs. K., age 36. A radical amputation of the right breast for adenocarcinoma was done on October 4, 1913. Soon after the operation there appeared a recurrence in a supraclavicular lymphatic gland, which appeared to be about ¾ inch in diameter.

Dr. I. Adler referred the patient to the writer on November 19, 1913. Under radium and röntgen-ray treatment the nodule disappeared. The patient disregarded the advice to continue the treatment. Two months later there developed a nodule about 1 inch long by ¾ inch wide by ½ inch thick, adherent to the third rib. The surgeon advised operative removal, which was done. The removal could not have been done completely, and particles of the tumor remained adherent to the rib. The patient died two months later with symtoms of metastasis in the brain.

It seems possible that if the second metastatic nodule had been radiated and no surgical interference had been attempted the rapid dissemination in the brain might not have taken place.

CASE 3. Mrs. B., age 54. Had the left breast amputated for carcinoma on April 7, 1911. In the summer of 1914 there developed a swelling measuring 2 inches long, ¾ inch wide, and 1 inch high, adherent to the left clavicle. The radiograph (Fig. 2) shows partial destruction of the bone, and consequently a metastasis in the left clavicle. The case was referred to the writer by the surgeon (Dr. Bodenheimer) in August, 1914. Under combined radium and röntgen treatment the swelling practically disappeared. At present, nine months after the beginning of the treatment, the patient is clinically well and there is no indication of a recurrence anywhere.

Though the patient was not observed long enough to be certain of an ultimate cure, it is remarkable that nine months after a metastasis in the bone was noticed there should not have taken place any apparent further dissemination of the carcinoma. The case is further remarkable as the second case on record in which a metastasis in the bone was influenced by radiation. The first case was reported recently by Pfahler (6).

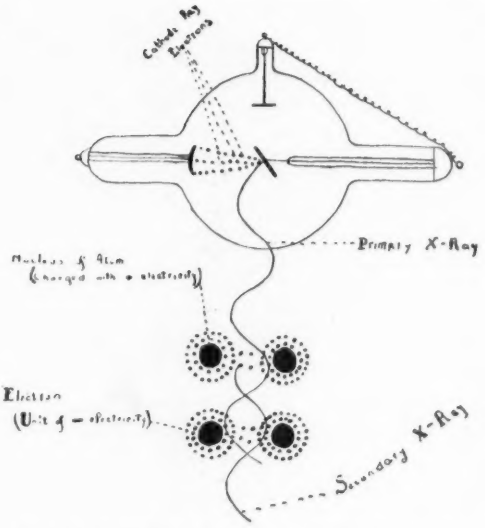

Fig. 16. A symbolic drawing of the structure of matter and the action of X-rays upon it.

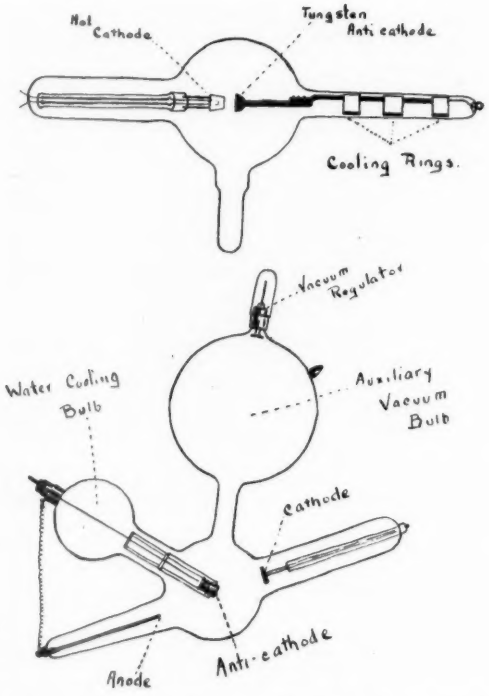

Fig. 17. Diagrams of two röntgen-ray tubes. The upper is the Coolidge tube, the lower the Gausstherapy tube.

CASE 4. Mrs. F., age 60, was operated upon in April, 1913, for carcinoma of the vulva. In September another operation was done with removal of inguinal glands on both sides. On November 24, 1913, the patient was referred for treatment by Dr. Rongy. There was a flat ulceration in the posterior commissure of the introitus vulval. In four weeks of combined radium and röntgen treatment, the local epithelioma healed. Three months later there appeared large masses of carcinoma in both inguinal regions which did not respond to the treatment, and the patient died in six months. While the treatment failed ultimately, there was a very evident local effect of the treatment.

CASE 5. Miss M., age 23, was operated on August 12, 1914, for a malignant tumor of the ovary (endothelioma). At the operation disseminated tumor-masses were found in the peritoneal cavity. The ovary and some of the tumor-masses were removed and the incision closed. A recurrence took place in the abdominal wall which was again operated upon. The wound never healed, and there developed at the lower end of the incision an ulcer about 2 inches in diameter. The patient was referred to the writer in October, 1914. She is still under treatment. Recently there has developed again a tumor-mass in the right upper half of the peritoneal cavity; but the ulcer cleared up, and a section made in April last of an excised piece shows granulation tissue and no evidence of tumor-cells.

CASE 6. Mrs. G., age 59. On April 24, 1913, she was admitted to the German Hospital, service of Dr. Seeligmann, where a diagnosis was made of primary carcinoma of the vagina. A piece was excised for microscopical examination which showed a squamous-cell epithelioma (Fig. 3). The condition was considered to be inoperable, and on February 27, 1914, the patient was referred to the writer by Dr. Seeligmann and Dr. Kessler.

The patient appeared emaciated, weighed 115 pounds, complained of continuous bloody, fetid vaginal discharge, constant backache, pain on defecation, rectal tenesmus, painful and frequent micturition. She was urinating from five to six times a night. On examination the labia and vulva appeared normal with the exception of the presence of a sanguineous fetid discharge. On separating the vaginal walls there is noticed, beginning about 1¼ inch from the introitus vaginæ, an ulcerated area which circled around the whole vaginal wall, but appeared to be deeper on the posterior side. The margins of the ulcer were indurated and the surface consisted of friable tumor-tissue, which was very easily detached. The vaginal canal was so constricted by the ulceration that one finger could hardly pass through. Rectal examination showed that the mucous wall of the rectum was not involved in the growth and the uterus appeared normal. The right uterosacral ligament appeared thickened, infiltrated, and hard.

A combined radium and röntgen treatment was employed. The patient received eight applications of radium of 12 hours' duration each with an interval of 36 hours between the applications. The amount of radium salt used was 50 mg. The tube was screened with 0.5 mm. of silver, 0.75 mm. of gold, and layers of photographic paper to protect against the caustic action of the secondary rays. The whole was enclosed in a sterile rubber tube. At the same time the treatment was supported with massive doses of X-rays.

In all ten X-ray treatments were given. A Gauss water-cooled tube was used. Penetration showed that 9½

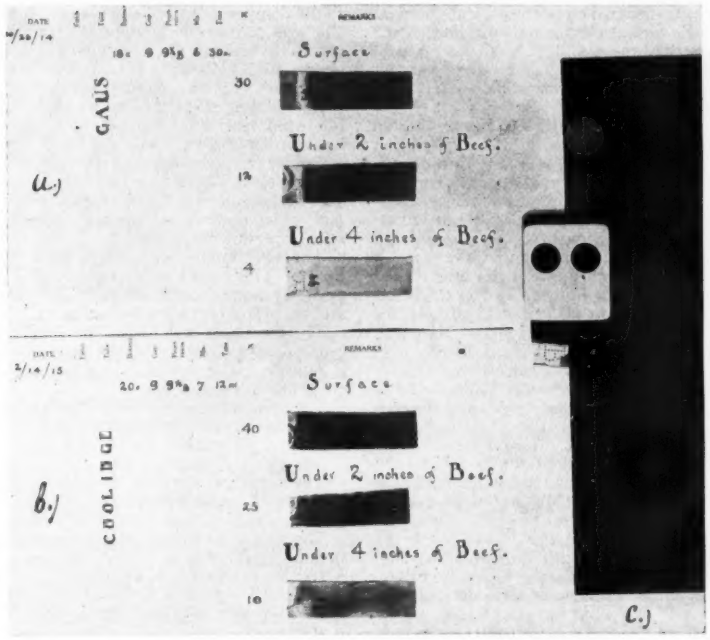

Fig. 18. Records of two experiments. *a*, An experiment with 4 inches of meat and a Gauss tube. *b*, An experiment with 4 inches of meat and a Coolidge tube. *c*, The Kienböck quantimeter and the method of estimation.

Bauer, 4½ M.A., were sent through the tube. The rays were filtered with 3 mm. of aluminum and 2 mm. of chamois leather. The rays were sent through four fields of the abdomen and through two fields on the back. Their combined quantity equaled 480 X as measured by Kienböck photographic strips. On May 26, 1914, the patient was presented to the Gynecological Section of the Academy of Medicine. Then she had no vaginal discharge, no backaches, no rectal discomfort, and no frequency or pain on micturition. She gained 15 pounds and was able to attend to her household duties.

Objectively the vaginal wall presented at a distance of 1¼ inches from the introitus vaginæ an annular indurated scarlike mass; the canal was even more contracted than when the treatment began. The surface of it was smooth and not friable. A piece was excised for microscopical examination throughout the whole thickness of the vaginal wall. The piece was taken from the right lateral wall on one hand in order to be nearer the right uterosacral ligament and on the other hand not to injure the bladder or the rectum. A microscopical examination of the piece showed absence of cancer-tissue, the latter being replaced by a connective-tissue and round-cell infiltration (Fig. 4).

Since then the patient gained 30 pounds more; i.e. 45 pounds since the beginning of treatment and she seems perfectly well.

Though fifteen months is not long enough for a positive prognosis, the chances for complete recovery of the patient are very good.

CASE 7. Mr. T., age 29. About the middle of June, 1914, and again on July 1, the patient had an attack of excessive pain in the epigastrium, radiating over the whole abdomen; he vomited yellowish fluid, and afterward had continuous bloody diarrhœa for about 14 hours, and only on the third day had the movements without blood.

On admission to the hospital July 1, 1914, the patient looked very sick. The eyelids were half closed; the tongue was dry and somewhat furred; pulse 60, temperature 100.4°; abdomen distended, tympanitic, most tender in right hypochondrium, less in left, still less over right iliac. No tenderness over McBurney's point. No evidence of gas or fluid in peritoneal cavity. Rectal examination showed slightly tender cords extending upward from prostate on both sides. No mass palpable; no blood on examining finger. Stools show particles of mucus and suggestion of blood. X-ray showed marked obstruction at the transition of descending colon into sigmoid — only a small part of the enema passed beyond obstructed part. The defect at the distal portion of descending colon began at the seat of obstruction and extended proximalward for about 3 inches, suggestive of a tumor of the colon in the region. Temperature ranged from 98° to 101°. The diagnosis was made of carcinoma of the sigmoid, and on August 27, 1914, an exploratory laporotomy was performed. Two incisions were made, one horizontally on the upper half of the abdomen and another on the right lower quadrant of the abdomen. In the sigmoid was discovered a hard nodular mass the size of a hen's egg, hard in consistency and growing from the inside of the sigmoid. The peritoneum was found to be studded everywhere with small

white tubercles, which appeared on microscopical examination to be metastatic foci of carcinoma. In view of the peritoneal dissemination, the condition was considered to be inoperable, and the primary sigmoid tumor was not removed. A colostomy was performed immediately over the tumor.

On September 9, the treatment with röntgen rays began. A Gauss water-cooled tube was used. Penetration showed that 9½ Bauer, 4½ M.A., was sent through the tube. The distance of the target was 18 cm. The rays were filtered with 3 mm. of aluminum and 2 mm. of chamois leather. Eleven fields were mapped out over the abdominal wall and twelve fields over the back. Each field was a circle 2 inches in diameter and there was a distance of a little over an inch between the fields. The treatment was continued until January 25, 1915. Fifty-eight treatments were given in all and during these the patient received 3,480 X measured by the Kienböck method. Of these units one-third was given directly over the tumor mass and the rest over the mapped-out fields.

At the end of January there developed symptoms of obstruction. He was operated upon twice, and died on March 12, 1915.

The following is the report of the autopsy, performed by Dr. R. A. Lambert, 35 hours post-mortem.

The body is that of a very much emaciated man, 155 cm. in length. Rigidity present. Moderate post-mortem hypostasis. In the skin over the abdomen there is a transverse scar about 15 cm. in length. There is a recent surgical wound about 10 cm. in length in the right inguinal region. In the left inguinal region there is a colostomy wound from which project exuberant granulations — in the center a probe can be passed into the intestine both upward and downward. There are no skin lesions and deformities.

Abdomen. In the abdomen there is a moderate amount of straw-colored fluid. Several loops of the intestines are adherent by old adhesions to the posterior surface of the tumor in the sigmoid. The latter is firmly adherent to the skin by a thick fibrous mass (Fig. 5). The peritoneum, especially in the pelvis, is studded with numerous white plaques, varying in size from 1 mm. to ½ cm. in diameter — the larger ones are quite firm to the touch. (Figure 6 shows a loop of small intestines studded with such plaques.) The mesenteric lymph-nodes are rather small and reddish on section.

Thorax. The thymal tissue is atrophic. There is no fluid in either pleural cavity, and both lungs show only a few pleural adhesions. The superficial lymph-nodes are not enlarged.

The *heart* weighs 200 gm. The pericardium is smooth throughout. The chambers are normal. The valves show no thickening. The musculature of the left ventricle measures about 1.5 cm. in thickness. The right ventricle measures about 6 mm. The aorta just above the valves shows a few early arteriosclerotic patches.

Aorta. Elastic, and shows a few early arteriosclerotic patches.

The *right lung* weighs 675 gm., is quite voluminous, and air-containing. The pleura is normal and smooth throughout. In the lower lobe and posterior part of the upper lobe the pleura is "doughy" in consistency, and on section the color is deep red with reddish gray patches. A considerable amount of bloody fluid exudes from the surface. The reddish gray areas referred to are rather firm and airless. The bronchi contain a bloody, frothy fluid, but are otherwise normal.

The *left lung* weighs 550 gm., and is similar to the right lung.

The *liver* weighs 1,220 gm. The right lobe is adherent to the diaphragm by old adhesions. It is normal in shape. The greater part of the right lobe is much paler than the rest of the organ, and on cut section there is a sharp line of demarcation between this portion of the liver and the remainder. The architecture of the organ here is well preserved, but the lobules have a uniformly yellowish gray hue, while the other part of the liver presents a reddish brown color. No thrombi are found in the portal vessels or in any of the vessels in either part of the liver.

The *spleen* weighs 175 gm. Its capsule is adherent to the diaphragm. On cut section the surface is pale and the malpighian bodies stand out very prominently and occupy a large part of the organ.

The *right kidney* weighs 110 gm. The capsule strips easily. The cortex measures about 8 mm. and shows perfectly normal architecture. The pelvis is not dilated, and there is no excess of pelvic fat.

The *left kidney* weighs 160 gm. It is rather congested, but is otherwise similar to the right.

Bladder. The vessels of the mucosa are injected, but there are no ulcerations.

The *prostate* appears somewhat large, but on section looks normal.

Ureters. Normal.

Adrenals. Normal.

The *œsophagus* shows in the mucosa of its upper portion a few small whitish plaques resembling those seen in the peritoneum.

The *stomach* is enormously distended with thin greenish fæcal matter. The mucosa shows post-mortem patches.

Intestines. No ulcers are found.

MISCROSCOPICAL NOTES

Heart. Normal.

Liver. The section was taken so as to include both the paler and the deeply colored parts in the liver. There is very little difference microscopically between the two zones. The deeper colored zone shows simply a much larger amount of blood in the capillaries. The liver-walls everywhere stain well, those nearer the centers of the lobules contain a few small fat droplets. No thrombi are seen in any of the vessels.

Kidney. The cells lining the convoluted tubules are somewhat swollen. The section is otherwise normal.

Spleen. The sinuses are throughout congested with blood. The malpighian bodies are moderate in size. The trabeculæ are not increased in thickness.

Intestine. Section 1 was taken through two loops of small intestine which were firmly bound together by old adhesions to the sigmoid tumor. These adhesions consist of a thick layer of connective tissue in which are occasional nests of tumor-cells. These nests are rather more abundant, however, in the muscular layers of the intestine than in the fibrous tissue connecting the loops. The tumor cells stain very deeply.

Section 2 (Figs. 7 and 8) was taken from the edge of the colostomy wound, shows a bit of skin with a wide zone of connective tissue beneath in which there are occasional groups of degenerated tumor-cells, and muscular layers and mucous membrane of intestine. There are relatively few groups of tumor-cells in the muscular layers, but the mucous membrane is rather densely infiltrated with the tumor. In the muscle especially one sees groups of tumor-cells, apparently degenerate, in the midst of mucoid material of the character that one finds in the so-called colloid carcinomata.

The *peritoneal nodules* are composed of dense connective tissue, with occasional groups of tumor-cells. The tumor-cells here, as elsewhere, stain poorly. No follicles of colloid material are present (Fig. 9).

Lymph-gland. No germinal centers are seen. The sinuses contain a rather large number of palely-staining cells. There is some increase in connective tissue, but no definite fibrosis except in one area. Section of a larger lymph-gland taken from the perirectal region shows very much the same appearance. In neither gland is there any evidence of great destruction of lymph-elements such as one might have expected after the prolonged radiation to which the patient was exposed. In larger glands a nest of tumor-cells is seen, and a mass of cells in a large thin-walled vessel.

Pathological diagnosis. Carcinoma of sigmoid with metastatic nodules in peritoneum, healed and recent abdominal surgical wounds, colostomy, intestinal adhesions causing obstruction, bronchopneumonia.

The post-mortem study of this case, which is done more completely than any other case reported in the literature, is very instructive and indicates clearly the value as well as the limitations of radiotherapy in the treatment of malignant tumors.

The following points of importance may be adduced from the analysis of the case:

Notwithstanding the continuous very large doses of röntgen rays, there was no injury to the skin, serous or mucous membranes, lymphatic glands, or parenchymatous organs. Figure 10 represents a section of the wall of the small intestine closely adjacent to one of the peritoneal tumor-nodules. The peritoneal endothelium is perfectly normal. At the same time the islands of tumor-cells in the peritoneal nodules were either completely destroyed and replaced by dense fibrous connective tissue or surrounded by the connective tissue and inhibited greatly in their growth. In over six months not a single one of the innumerable minute nodules found at the operation developed into a large metastasis. Only in one lymph-node there was found a small island of carcinoma. The original sigmoid tumor did not increase in size during the time. It is thus self-evident that the actinic rays exert a specific deleterious effect on carcinoma-cells, in the same quantity which leaves the rest of the organism intact. On the other hand, this selective action has its distinct limitations. The relation between the penetration, the absorption, and the distance between the point of origin of the rays and the tumor to be influenced on one hand and the efficiency of the therapeutic action on the other hand was indicated above. But one more important factor must be added; namely, the size of tumor-mass. By analogy with recent physical studies on selective absorption of X-rays by various metals it seems feasible to suppose that the selective active action of X-rays and Γ-rays on a tumor is due to a greater absorption of the rays by tumor-tissue than normal tissue. As a result, less of the rays penetrate into the next layer of tumor-tissue than would have been the case if normal tissue were interposed between this layer of tumor and the rays. This difference in the mass of tumor offers the only explanation of the fact that the deeper part of the sigmoid tumor, which was hardly more than 5 cm. from the skin, was not influenced by the rays, while the tumor-islands in the peritoneal nodules, some of which were situated at a many times greater distance from the skin, were either destroyed or deeply influenced by the rays.

Two conclusions of great practical importance may be drawn from the analysis of this case: First it seems plausible to suppose that if at the first operation the primary tumor would have been removed and the radiation applied only to the peritoneal nodules a recurrence may have been delayed for a long time. The acute obstruction which was the direct cause of death may also not have taken place, since the loops of the small intestines became adherent to the posterior surface of the primary tumor. This clearly indicates the importance of combined surgical treatment and radiotherapy of malignant tumors. The gross tumor should be removed surgically even when a radical operation cannot be performed, then the small islands of cancer-tissue may be destroyed by raying even at a distance; i.e., even a metastasis may be influenced by the rays at its incipiency. This leads again to the second important conclusion to be drawn from the analysis of this case; namely, the importance of prophylactic treatment. Prophylactic post-operative radiotherapy has not been employed long enough and on a sufficient number of cases for a correct statistical estimation of its value. But this case indicates that minute nodules may be influenced by the rays at a great distance from the skin. Consequently a systematic prophylactic radiation must destroy all the minute groups of tumor-cells transported immediately before and during the operation. It will fail in those cases in which there existed already at the time of the operation large secondary metastatic tumors.

CASE 8. M. M., age 12. Was referred to the writer on January 14, 1915, by Dr. Robert T. Morris, for treatment by radium, with a diagnosis of an inoperable giant-cell sarcoma of the right lower jaw. A small piece was removed for microscopic examination and showed a sarcoma with numerous giant cells and actively growing spindle cells (Fig. 11).

The patient was given combined radium and röntgen treatment. A tube with 50 mg. of radium was inserted into the tumor and kept for 18 hours and the same re-

Surgeon	No. of patients treated	Organ	Died	Discontinued treatment	Became worse	Not improved	Improved	Became operable	Clinically cured	Operable cases
Doederlein		Uterus					54			35
Cheron and Duval	158	Uterus				2	110	12	34	2
Allman	85	Uterus	15				15	20		
Wertheim	102	Uterus	23		8	21	31	19		21
Guisez	35	Œsophagus							3	
Werner	314	Various					64			
Pinch	196	Various	21	19		52	95		9	
von Eiselsberg	48	Various	11	18	7	1	5		6	
Schmitz	23	Various				19	2		2	
I. Levin	41	Various	13	11		14			3	
Total	1002							51	57	

peated once a week for 5 weeks. Another tube with 25 mg. of radium was placed outside to the skin of the cheek and kept for 18 hours. Figure 13 was taken immediately after the beginning of the first radium treatment and shows the two tubes *in situ*.

Following the radium treatment röntgen treatment was given by the aid of a Coolidge tube. The skin of the right cheek was divided in six fields each ½ inch in diameter and 30 X was sent through each field. Four treatments were given through the mouth, each of 40 X. So that in all the patient received 340 X.

Eight weeks after the beginning of the treatment a specimen was again removed for microscopic examination from the same region from which the previous was obtained. The section shows a very loose connective tissue relatively poor in cells and beneath this a denser zone of cellular connective tissue. No giant cells or distinct spindle cells are present (Fig. 12). A radiograph taken at the same time shows that the whole tumor is surrounded by a great deal of new-bone formation (Fig. 14). An examination through the mouth shows the tumor to have completely disappeared and instead there is present a large cavity lined by a shell of bone.

It is too early to draw any conclusions as to the final outcome of this case, but apparently the tumor-tissue is being replaced by newly-formed connective tissue and bone.

STATISTICAL ANALYSIS OF THE LITERATURE ON RADIOTHERAPY OF MALIGNANT TUMORS

In order to obtain a better estimate of the results reported in the present study the writer deemed it of advantage to compare them with some of the more recent reports of other investigators. The publications of the last two years in which the modern methods of radiotherapy were employed were analyzed.

Of the very extensive literature on the subject only those reports were selected in which the whole number of cases treated in a certain clinic were given and not the selected favorable cases only. The accompanying chart presents graphically the result of the analysis.

The names in the first column do not always represent the author of the article, but frequently the name of the chief of the clinic, which is occasionally important for the true estimation of the report. Nos. 7, 8, 9, 10, 11, 12, 13, 14, 15 of the bibliography give in rotation the articles analyzed. The report of Doederlein's clinic is given, though the whole number of treated cases is not indicated, in order to show that a man of his clinical experience undertook to treat 35 operable cases with radiotherapy alone. But his cases are not included in the total calculation of the figures.

Cheron and Duval state that a certain number of their cases remain cured after 4 years. They also report that of the 51 cases of carcinoma of the uterus which became operable in many of the subsequently extirpated uteri no carcinoma-cells were found. Guisez reports that 2 of the 3 cured cases of carcinoma of the œsophagus remain well after 2 years. Von Eiselsberg and his school are very cautious and even pessimistic in their valuation of radiotherapy and still they report 6 clinically cured cases out of a total of 48 inoperable cases, or 12 per cent of the cases treated.

The chart shows a total of 1,002 cases. Of these 57 cases were clinically cured and 51 cases became operable. There are reported in all 58 cases treated by radiation alone which were in an operable stage. Of these 35 cases belong to Doederlein and were not included in the calculation. The 21 cases of Wertheim must be deducted from the sum total of cases treated but not from the clinically cured cases, since Wertheim does not give the number of clinically cured cases. The 2 operable cases of Chevron and Duval must be deducted both from the sum total and the number of clinically cured cases. There remains a total of 979 cases of which 55 are reported clinically cured. Of the 51 cases which became operable at least 25 per cent, or 12 cases, must have also become clinically cured. This gives a total of 67 cases or 6.7 per cent clinically cured. These figures are similar to those reported by the writer, which are shown in the last line of the chart.

RATIONALE OF RADIOTHERAPY

A therapeutic method which is capable of producing a clinical cure in 6.7 per cent of a total of 1,002 inoperable cases of malignant tumor is by far superior in its efficiency, as well

as the number treated, to any therapeutic measure which was ever offered for these cases.

But these numerical results do not indicate the true value of this method of treatment. As stated above, the therapeutic action of the actinic rays is not entirely local. The rays may destroy cancer-cells at considerable distance from the source of the rays. But only the hardest rays can reach at that distance. They again represent a small fraction of the whole beam of rays and their action diminishes in the inverse ratio to the square of the distance. Consequently, the further the distance of the tumor from the surface of the body, the smaller its size must be in order to be destroyed by the rays. Minute metastatic nodules can be destroyed by the aid of radiotherapy at a great distance from the surface of the body. This observation, strikingly illustrated in Case 7 of the present report, shows the actual rationale of radiotherapy in the treatment of malignant tumors, its relation to surgical treatment, and the road to the future progress.

It would be out of place to describe here in full the correct methods of radium and röntgen therapy and the proper combination of both, and of radiotherapy with surgery. Some indications of the methods used were given in connection with the Cases 6, 7, and 8. Those interested may find complete description of the technique in previous publications of the writer (16).

Correct radiotherapy implies a thorough understanding of the pathological and clinical condition of the patient as well as of the technique, dangers, and limitations of the therapeutic measure. The great success of radiotherapy in Germany dates from the time when the surgeons and gynecologists themselves undertook this method of treatment instead of referring the patients to the radiographers. The future success of the whole field of treatment of malignant tumors depends upon a very close coöperation between the radiotherapeutist, surgeon, and pathologist.

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NITROUS OXIDE IN LABOR[1]

By N. SPROAT HEANEY, M.D., Chicago

SINCE the introduction of narcotics and anæsthetics into general medicine there has been a constant effort to adapt their usage to the alleviation of the pain in labor, but difficulty has been met in securing efficiency of action with safety to mother and child.

The literature dealing with the administration of chloroform, ether, chloral, morphine, and scopolamine, and with the various methods of producing local anæsthesia to secure painless labor is familiar to all of us and need not be mentioned in this paper. Neither is it necessary to enter into a discussion of the failures or dangers of these various drugs, since these things also are well known.

Lynch[2] in a recent paper states that Klikowitch of Petrograd, in 1880 was probably the first to use nitrous-oxide gas during labor. He gave a mixture of 80 parts of nitrous oxide and 20 parts of oxygen to a series of 25 cases. As soon as the cervix admitted one or two fingers he began the use of the gas and he continued it intermittently throughout the entire labor. He gave only sufficient to abolish pain but not enough to produce unconsciousness. The contractions were never diminished in intensity but, to the contrary, were often increased. The fœtal and maternal pulse were not much altered. Though his results were so gratifying, his method found

[2] J. Am. M. Ass., 1915, March 6; Illinois M. J., 1915, April.

[1] Read at the meeting of the American Gynecological Society, White Sulphur Springs, West Virginia, May 18–20, 1915.

no followers. Tittel in 1883 and Doederlein in 1886 also wrote of nitrous-oxide gas in labor but they undoubtedly administered it to the surgical degree.

During the past ten years J. Clarence Webster[1] at the Presbyterian Hospital has been largely substituting nitrous-oxide gas and oxygen for ether in obstetrical work. Versions, forceps, cæsarean sections, and various other obstetrical operations are performed under this anæsthetic, when it seems better suited to the condition of the patient than ether. He also early used it for the conduct of normal labor in the second stage, allowing the patient a light degree of anæsthesia during pains, with a return to the normal state between pains.

Lynch, in August, 1913, began to use nitrous-oxide gas and oxygen in labor in the method to be described in this paper, and subsequently I began independently to use it. The various members of the Obstetrical Department at the Presbyterian Hospital have now had a large experience in its administration and each has added some perfection in technique or has otherwise contributed to our general knowledge regarding the subject.

With a proper machine and a nasal inhaler nitrous oxide may be given to the extent that the patient does not experience pain during labor, yet maintains her consciousness and, if need be, can follow the directions of the attending physician. If oxygen is administered at the same time this stage of analgesia is more easily maintained and the headaches sometimes complained of after pure nitrous oxide are much more infrequent. How much gas is necessary to bring a patient to the stage of analgesia depends somewhat upon the efficiency of the machine used, but principally, upon the susceptibility of the individual. Some require more and others less. The less nitrous oxide required to produce analgesia, the more oxygen that is necessary. Usually the mixture is such at the beginning of a pain that three to four quick inhalations are sufficient to produce analgesia, while the patient retains her normal color and remains entirely conscious. Each patient differs so that the mixture must vary also. A few pains will establish the mixture necessary in each case. When once analgesic more oxygen may be given, until at the end of a long pain either pure oxygen is given or the nose-piece removed.

If the mixture is too rich, analgesia is imperfect and the patient passes into a deeper stage and may complain of pain; she then begins to become cyanotic, the consciousness becomes clouded, and, if pushed further, the patient enters the familiar stage of surgical anæsthesia with its attendant phenomena. When giving the gas for the first time the tendency is to give much more than is necessary; the least possible amount usually secures the most satisfactory analgesia. By careful observation the analgesic stage can be maintained for hours. The patient may be directed, as Lynch advises, to keep the eyes open during the administration and to watch a light placed in a convenient location. If it is noted that the light is beginning to appear unnatural, then the patient must breathe through the uncovered mouth. If the operator observes that the lids are beginning to droop or that the lips are beginning to show a suggestion of cyanosis the patient is directed to breathe deeply through the mouth and quickly returns to the analgesic state.

When it is explained to the patient that she is not supposed to sleep but to have full control of her faculties, and that in the event that she feels herself slipping into unconsciousness that she must breathe through the mouth, most women will be able to keep themselves in the desired state of equilibrium. Occasionally one meets, however, an individual who, because she fears that she will have pain will, if left to her own devices, continually pass into too deep a stage. Careful watching of such an individual, with a sharp direction at the proper moment to breathe through the mouth, prevents this undesirable overdosage. No physical harm results from this slight degree of overdosage, except that if the patient is in the second stage, her unconsciousness prevents her from giving the very useful help so characteristic of the proper stage of analgesia. The administration may be begun at any time when the pains begin to be severe. Usually this is left to the inclination of the patient. Rarely does she consider it necessary before dilatation is well advanced; usually it is not asked for until the membranes have ruptured or are ready to be ruptured.

The hand placed upon the abdomen feels the contraction of the uterus before the patient perceives the pain. At this time the nasal inhaler is placed over the patient's nose and she is directed to take the necessary number of inhalations previously determined to be necessary in her case. In the event that she is in the second stage she then holds her breath and bears down or pulls upon the straps provided for this purpose. When this breath is exhausted, if apparently well within the analgesic zone, she breathes again through the nose, some oxygen

[1] J. Am. M. Ass., 1915, March 6.

being added to the mixture, and bears down again. If it is noted that the patient is getting too much, she breathes through the uncovered mouth and bears down. The usual second-stage pain is divided into three or four expulsive efforts. The patient usually knows when the contraction has ceased, because she no longer desires to bear down, at which time the inhaler is removed and the hand is placed upon the abdomen to await the signal for the re-administration of the gas. By questioning the patient between pains, the mixture necessary to obtain the ideal result is quickly determined.

To insure absolute painlessness the gas may be given to the surgical degree during the last few pains; or if, as it frequently happens, the birth begins to advance too rapidly, ether may be mixed with the gas or substituted for it.

In a few cases manual dilatation of the cervix was done under analgesia, the patient entirely conscious yet feeling no pain. In the same way I have on a number of occasions converted a persistent posterior to an anterior presentation, introducing the whole hand into the vagina, the patient though conscious complaining of no pain.

The frequency of the labor pains is not disturbed by nitrous oxide, nor is the duration of the contraction, when the patient is kept in the equilibrium of analgesia. Indeed, during the expulsive stage, the efficiency of the pains is increased, since the patient can use the secondary muscles of expulsion to their utmost capacity without fear.

The fœtal heart-tones are not disturbed and the baby cries immediately upon birth; its dose of anæsthesia is as evanescent in its action as is the mother's. The mother is always conscious and in full possession of her faculties within a minute or two of the birth.

There is no relaxation of the uterus, and providing that ether has not been used the third stage terminates as promptly and as satisfactorily as when no anæsthetic is used.

The perineum is usually repaired under analgesia, preceding the birth of the placenta. This generally proceeds without difficulty, though occasionally the stitches near the anus may produce slight pain.

In the same way I have used the gas for the removal of stitches in highly nervous women, and also for the painful procedure of removing a uterine pack.

The amount of gas necessary for the conduct of a case varies greatly with the type of machine used. If no shutoff is attached, the gas remaining in the bag at the end of a pain escapes and much gas is wasted during the course of one administration. A wasteful operator will use much more gas than is necessary. With experience one will find that the amount is also reduced. One of the small cylinders has more than once sufficed for more than three and one-half hours' administration. The cost of the gas may be materially lessened in hospitals by the use of the large cylinders. For outside work an efficient portable apparatus, which with cylinders will fit in a suitcase, is made by several different manufacturers.

Nitrous-oxide-and-oxygen analgesia may be given just as efficiently in a home as in a hospital. No expert anæsthetist is necessary. With a little instruction a layman may give the gas, the obstetrician carefully controlling the administration. That the physician may remain clean and yet administer the gas himself, Dr. C. H. Davis of our staff has invented a foot attachment, by which the flow of gas is controlled.

From our observations our staff is united in the belief that in nitrous-oxide-and-oxygen analgesia we have not only an efficient means of controlling the suffering in labor but also a safe means, free of all the well-known and valid objections against other means of securing painless labor.

INTESTINAL OBSTRUCTION CONSECUTIVE UPON POSTERIOR RETROCOLIC GASTRO-ENTEROSTOMY

With Description of a Method to Avoid Similar Complications

By ALEXIS V. MOSCHCOWITZ, M.D., F.A.C.S., New York
Professor of Clinical Surgery, College of Physicians and Surgeons, Columbia University; Attending Surgeon, Mt. Sinai Hospital; Visiting Surgeon, Har Moriah Hospital
AND
A. O. WILENSKY, M.D., New York
Adjunct Attending Surgeon, Mt. Sinai Hospital

THE report of a case is herewith given, illustrating a most unusual complication following upon gastro-enterostomy. The few similar cases, seven in number, which have been reported in the literature, are briefly cited, and an attempt is made to describe the mechanism by which this variety of ileus can and did occur. Finally a method will be indicated whereby this complication can be avoided.

Mt. Sinai Hospital, No. 150,461. J. F., an Italian, age 25, was admitted December 1, 1914, to the medical service of Dr. Libman, with the history that for one and one-half years previously he had suffered from gastric disturbances. More particularly there had been marked pain and burning in the epigastrium after the ingestion of food, which had always been relieved by vomiting. Of late the vomitus was very profuse in amount, and consisted of partly digested food. At no time had there been any vomiting of blood. There was progressive loss of weight, in spite of the fact that the patient had developed a ravenous appetite.

With the exception of a tender area in the epigastrium, to the right of the median line, the physical examination was negative. The examination of the stomach contents after Ewald test breakfasts showed invariably the presence of excessive hyperacidity, blood, and retention of food much beyond the normal period. The X-ray studies demonstrated an obstruction at the pylorus, with marked dilatation of the stomach.

A diagnosis of duodenal ulcer, causing pyloric obstruction, with secondary dilatation of the stomach, was made, and an indication for operative treatment being evident, the patient was transferred on December 5 to the surgical service of Dr. Moschcowitz.

Operation, December 9, 1914, by Dr. Moschcowitz. A transverse (Sprengel) incision was made through the upper part of the left rectus muscle. The stomach was enormously dilated, and the pylorus and first portion of the duodenum were found to be occupied by a large mass adherent to the surrounding structures. This was diagnosed as a callous ulcer, obstructing the lumen of the gut. A short-loop posterior retrocolic gastro-enterostomy was made by the suture method, and the pylorus was excluded by plicating the anterior wall of the stomach. At the conclusion of the operation, the stoma was parallel with the greater curvature of the stomach; the afferent loop passed from left to right, and the efferent loop proceeded toward the right and passed downward in the general direction of the right iliac fossa. The patient reacted well from the operation, and the usual routine treatment employed on the service was instituted.

On the second day after operation, contrary to what we are accustomed to see, the patient vomited small quantities of coffee-ground material at frequent intervals, and on passing a stomach tube forty-eight ounces of a similar fluid were obtained. Thereafter the vomiting ceased for three days.

On the fifth day after operation the patient again began to vomit, the vomitus being a dark-brown fluid. Twenty-four ounces were obtained on passing the stomach tube. On the ninth day the patient complained for the first time of slight abdominal cramps; the abdomen, however, was not distended, there was no visible peristalsis, and gas was being freely passed per rectum. Seventy ounces of fluid were obtained from the stomach. Thereafter the tube was passed regularly every eight hours, and always from six to fourteen ounces were obtained. On the eleventh and twelfth days the stomach was found to be empty, but the general condition of the patient deteriorated markedly. He was slightly stuporous and a urinous odor could be detected in the breath. The urine contained much albumin and many hyaline and granular casts. It was thought at this time that possibly the condition of the kidneys might account for part or the whole of the clinical picture.

On the fourteenth day the stomach was again emptied of thirteen ounces of fluid. The patient had complained of no pain; there was no abdominal distention and no visible peristalsis. On the evening of the same day, for the first time, slight peristaltic erections were visible through the abdominal walls. General condition of the patient very poor. It was thought at this time that some form of ileus was present, and exploration of the abdomen was decided upon.

Operation by Dr. Wilensky. The abdomen was reopened in the line of the original incision, and owing to the wretched general condition of the patient this was done without general anæsthesia. The stomach was found to be enormously dilated, reaching almost to the pelvis, while the small intestines which presented were collapsed. On drawing these aside, it was seen that the duodenum and the afferent loop of the jejunum were also distended as far as the stoma, and that the obstruction was formed by the efferent loop as it passed downward and to the right, turning sharply on itself toward the left, and had insinuated itself in the artificial foramen formed by the afferent loop, the posterior parietal peritoneum, and the under leaf of the transverse mesocolon, as far as its fixation to the anastomosis. Almost the entire small intestine had followed and lay in the left half of the abdomen (Fig. 1). The mesentery of the small intestine where it was caught in the ring was somewhat swollen and œdematous, and the margins of the ring were likewise infiltrated, especially that part formed by the ligament of Treitz. The loops of intestine passing through the ring were nowhere adherent

to its margins, and it was an easy matter to rapidly reduce the "hernia." The foramen was apparently stretched and admitted three fingers. It was obliterated by suturing the afferent loop to the ligament of Treitz. It could now be seen that the loop of jejunum at its application to the stomach was slightly twisted on its longitudinal axis. The abdomen was then rapidly closed by through-and-through sutures.

The patient bore the operation fairly well; on the next day a large mass was noted in the left submaxillary triangle, evidently a deep-seated abscess. The patient's condition rapidly became worse and death occurred the same day.

We were fortunate in obtaining a post-mortem examination, an abstract of which is herewith given.

Stomach is enormously dilated and contains forty ounces of poorly digested contents. Posterior gastro-enterostomy found in good condition. The jejunal loop, measured from the ligament of Treitz to the stoma, was about six centimeters long. The artificial foramen formed by this portion of the jejunum and the transverse mesocolon was almost obliterated by sutures passed between the jejunum and the ligament of Treitz. On opening the stomach, the stoma of the gastro-enterostomy was found to be in good condition, and the mucosa almost completely healed over it. Pylorus was patent. On the anterior wall of the stomach in the pyloric region was a layer of sutures, but no complete closure of the lumen of the pylorus had thereby been obtained. In the first portion of the duodenum about one centimeter from the pylorus there was a dense fibrous constriction, the lumen of which barely admitted the little finger. The mucosa on the gastric and duodenal sides of this constriction was whitened and presented a cup-shaped irregular depression, apparently the remains of a healed duodenal ulcer. The duodenum as far as the gastro-enterostomy was distended with small intestinal contents.

PREVIOUSLY REPORTED CASES

Steudel (1). A carcinoma of the stomach was extirpated in a woman 54 years of age and a posterior gastro-enterostomy made with a Murphy button, after the method of von Hacker. On the twelfth day there was sudden collapse, without any signs of obstruction, and the patient died five days later. At the autopsy, however, an obstruction was found, a short loop of small intestine having passed from right to left through the artificial foramen.

Peterson (2). The greater part of the stomach was resected for a pyloric carcinoma in a man 54 years of age and an anterior gastro-enterostomy made with a Murphy button. On the sixth day the patient went into collapse, developed signs of obstruction, and died very soon thereafter. At the autopsy it was found that a large part of the small intestine had passed from right to left through the foramen.

Peterson (3). In a man 51 years old a posterior gastro-enterostomy was made after the method of von Hacker, as a palliative measure for a carcinoma of the stomach. On the eighth day there developed mild symptoms of ileus, and the patient died two days later with a well-developed pneumonia. At the post-mortem examination the whole of the small intestine was found to have passed from right to left through the ring.

William J. Mayo (4). An anterior gastro-enterostomy was made with a Murphy button in a man 41 years of age for an ulcer of the pylorus and lesser curvature of the stomach. On the fourteenth day there were signs of intestinal obstruction, which lasted forty-eight hours. On the sixteenth day the button was passed, and the patient was discharged well. At the end of a year the patient returned, complaining of constant pain above the umbilicus. At the operation the jejunum was found twisted on its longitudinal axis and had passed behind the afferent loop. The old gastro-enterostomy was divided and a new retrocolic anastomosis established. The final result is not given.

Gray (5). A posterior retrocolic short-loop gastro-enterostomy was made by the suture method in a woman 31 years of age, with a typical ulcer history. Signs of obstruction developed on the sixth day, and on reopening the abdomen the whole of the small intestine was found to have passed through the ring from left to right. The ring was closed by suturing the inferior leaf of the mesocolon. The patient recovered.

Gordon (6). In a patient who was operated upon for intestinal obstruction, and in whom a gastro-enterostomy had been made previously, this variety of ileus was found, the gut having passed from right to left. No details are given. The patient recovered.

Barker (7). Two years after a posterior retrocolic short-loop gastrojejunostomy had been made in a woman 28 years of age, the abdomen was again opened for intestinal obstruction. The whole of the intestine was found to have passed behind the afferent loop (the direction is not given in the report), and in addition the whole mass was twisted one complete revolution at the site of strangulation. The patient recovered.

After the completion of a posterior retrocolic gastro-enterostomy, the afferent loop of the jejunum is attached at two points; namely, at the duodenojejunal junction and at the stoma. This attachment forms an artificial foramen, the boundaries of which are approximately the following: posteriorly, the peritoneum lying in front of the vertebral column; superiorly, the inferior leaf of the transverse mesocolon, plus the gastrojejunal stoma; anteriorly and inferiorly, the afferent loop of the attached jejunum. The size of this foramen depends upon the length of the afferent loop of jejunum. Up to within the last decade, surgeons were rather liberal in estimating the required length of this loop, but lately brevity has been aimed at, and the former "long-loop" operations have been abandoned in favor of the "short-loop" operation; frequently the statement is even met with that a "no-loop" operation was made. The latter, however, is manifestly impossible. To perform what would be literally a "no-loop" operation, the suturing would have to be done either within the abdomen at an impossible depth, or it would have to be done with so much twisting of the attached jejunum as to be fraught with unwarranted danger. In our own work we have always aimed to take the afferent loop as short as possible, and as short as would be commensurate with safety.

Furthermore, we have also aimed at one ad-

ditional point; namely, to place the stoma as far over to the right as possible. We have been fortified in this view by such an authority as Hartmann, who even advocates the placing of the stoma in juxtaposition to the pylorus. The afferent loop, depending upon its application at the site of the anastomosis, is turned either toward the right, and proceeds downward in the general direction of the right iliac fossa, or it follows its more natural inclination, and will proceed toward the left in the general direction of the left iliac fossa. The former is anatomically incorrect, but physiologically correct (isoperistaltic); while the latter will be anatomically more correct, but less so physiologically (antiperistaltic). Up to the experience related in the history of our case we had not taken any positive stand in the question of isoperistaltic and antiperistaltic attachment of the jejunum. Both methods have their warm advocates and adherents. We have decided the question from case to case, as it appeared to be most feasible and yet to do justice to the postulates previously mentioned. It is important to know here that in the case under discussion the isoperistaltic method was used.

A few surgeons, e.g., Kocher, make the incision into the intestine transversely to its long axis; but most surgeons make the incision parallel with its long axis, and we do not deviate from this method.

One other point which merits discussion is the direction of the incision in the stomach. Some surgeons clamp the stomach transversely to its long axis, the handles of the clamp being directed toward the head of the patient; the handles are then brought to the right of the patient, and the gastro-enterostomy is finished in this position. It is self-evident that in so doing the portion of the stomach operated upon must be twisted through an arc of at least ninety degrees. We have always feared this twisting, and have therefore continued to make the incision parallel with and near the greater curvature of the stomach.

A certain amount of care is required in coapting the jejunum to the wall of the stomach. If this is executed in a haphazard and careless manner, more particularly if a Murphy button is used, a certain degree of rotation may be imparted to the jejunum, with the result that at the conclusion of the operation the coil of jejunum lies twisted on its longitudinal axis in an unnatural manner.

The physiological functions of the parts involved in the stoma usually lie dormant for some time after the completion of the operation; they therefore tend to retain the position imparted to them by the operator. Any twisting at the time of the operation is likely to become even more accentuated. One of the reasons for these twists may be the gauze compress placed for the protection of asepsis behind the suture line. If clumsily executed, even the withdrawal of this gauze may initiate uncalled-for twists. I have always taken the precaution to remove this gauze toward the right in the isoperistaltic attachment and toward the left in the antiperistaltic attachment.

If we now investigate the method of the operation as carried out in the present instance, the following points will become manifest:

1. At the time of the operation the stomach was enormously dilated, so that the ultimate stoma was certainly below the horizontal of the normal location of the duodenojejunal angle. It is quite possible that some blame is to be attached to this contingency; but we are inclined more to the belief that it would be more likely to result in some angulation and functional disturbance of the stoma, which, however, was not the case.

2. Attachment of the loop in an isoperistaltic manner.

3. Incision of the stomach parallel to the greater curvature.

4. The shortest possible loop was taken, as was still evident at post-mortem, when, even after stretching by the large amount of small intestine passing through the ring, it measured at most only six centimeters.

All in all, and without wishing in the slightest degree to find any justification for our methods or mistakes, we cannot find any deviation from the methods carried out in many other cases and in vogue with many, if not most, surgeons. On close scrutiny, about the only fault we can find is a fault which is inherent to the operation of gastro-enterostomy as such, namely, that an unnatural foramen is created within the abdomen; and it is well known that, in a certain percentage of these, loops of intestine or omentum will find their way into such an opening. Once a knuckle of gut has found an entry, the muscular contractions, as in a hernia, tend to become more violent and to insinuate more and more of the intestinal coils through the aperture; so that by the time these patients are operated upon, or come to autopsy, in nearly every case the entire small intestine has passed through the ring.

As a general rule, the ring is large enough to accommodate the two loops of intestine comfortably, and no actual strangulation occurs. The gut is usually not adherent to the margins of the ring, and reduction of the "hernia" is

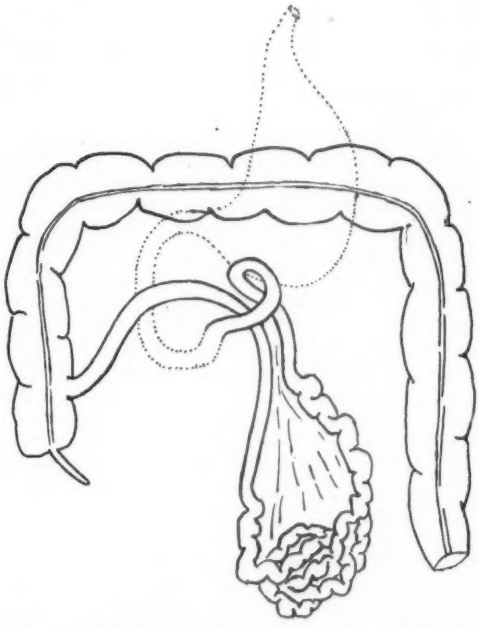

Fig. 1. Diagrammatic illustration of intestinal obstruction found at secondary operation.

very easily effected. This is reflected clinically in an atypical symptom-complex. The pain is vague, slight, or indefinite; peristaltic contractions are faint, not characteristic or absent; and small amounts of gas or fæces may be passed from the rectum. Vomiting is usually present.

Assuming now that our criticisms and deductions are correct, it must be patent that there exists a slight fault in the technique of gastro-enterostomy as now executed; namely, that an artificial foramen is formed. Given such a foramen there exists always the possibility that, in a certain percentage, intestines or omentum will find their way into and through it and will cause symptoms. Naturally the number is small compared to the large number of gastro-enterostomies that are made, no more perhaps than with herniations through the foramen of Winslow, in which analogous conditions exist. The question therefore arises, How may we avoid the formation of this foramen? The solution of the problem appears to be very simple by the addition of the following step; namely, to suture the margins of the opening together, utilizing for this purpose the afferent loop of jejunum and the inferior leaf of the transverse mesocolon. Three or four sutures of Pagenstecher's thread appear to be ample to obtain a complete obliteration (Fig. 2).

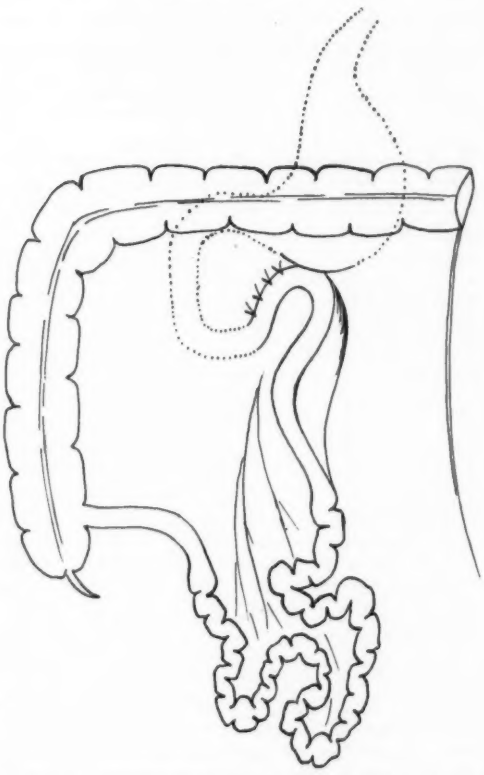

Fig. 2. Diagrammatic illustration of obliteration of foramen formed in the course of gastro-enterostomy.

It is preferable to use the proximal loop, because whatever narrowing of the lumen may be caused thereby occurs in the loop, which serves merely for the transmission of bile and pancreatic juice. It is quite within the range of possibility, also, that such an anchoring may aid in the prevention of the formation of a vicious circle.

This little refinement practically amounts to only this much: that it converts the short-loop operation into a practically no-loop operation.

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PSEUDOFRACTURE OF THE SESAMOID BONES OF THE BIG TOE

By W. W. BOARDMAN, M.D., San Francisco
From the Stanford University Medical School

MY attention was first called to the possible occurrence of fracture of a sesamoid bone beneath the head of the first metatarsal by the following case:

Miss R., age 25, presented herself for examination in May, 1914, complaining, on walking, of pain under the base of the right big toe. Family and past history unimportant. She had had no trouble with her foot until 1906, eight years ago, when in hurrying upstairs her right foot slipped off the stair, causing extreme hyperextension of the big toe. There was some immediate pain, but no distress was noted during the following two hours while she was seated quietly. On attempting to walk, great pain was felt under the base of the big toe, and examination showed swelling in the region of the metatarsophalangeal articulation with tenderness to pressure on the plantar surface. With partial rest for a week the tenderness, swelling, and pain disappeared and she resumed her ordinary active life. During the next seven years she suffered no inconvenience except for an occasional sharp twinge of pain under the head of the first metatarsal bone, on walking. In 1913, while playing a hard game of tennis, she felt a sharp pain in the right foot, which persisted for several days, accompanied by swelling and tenderness to pressure under the big toe. With partial rest for a week the symptoms disappeared. A few weeks later the patient felt dull pain in the foot after dancing all evening. This pain persisted, being very severe on walking and on pressure. Strapping the foot in the region of the distal end of the metatarsals with adhesive gave relief, but the tenderness returned on removal of the strap. For the past few months the tenderness has been present off and on, usually only felt on walking, never felt at night. There may be a sharp pain for one or two steps and no more for the rest of the day. The patient states that she is troubled especially in the morning and after sitting still for a time. She has trained herself to walk on the outside of the foot with some relief.

Examination showed no appreciable swelling; pressure over the inner side of the distal end of the first metatarsal caused pain; no limitation of movement of the joint; no pain on extreme flexion or extension of big toe; however, pressure over tibial sesamoid was more tender during extreme extension. Slight tenderness was produced by extreme adduction, none on abduction.

Radiographic examination showed a definite separation of the tibial sesamoid into two portions by a lateral line of cleavage. The diagnosis was apparently fracture of the tibial sesamoid.

"Sesamoid bones are small rounded masses, cartilaginous in early life, osseous in the adult, which are developed in those tendons exerting a great amount of pressure upon the parts over which they glide. They are invested throughout their whole surface by the fibrous tissue of the tendon in which they are found, excepting on that side which lies in contact with the part over which they play, where they present a free articular surface."

The sesamoid bones beneath the head of the first metatarsal are two in number and are developed in tendons of the flexor brevis hallucis. This muscle divides near its insertion into two parts which are inserted into the inner and outer sides of the base of the first phalanx of the great toe, a sesamoid being developed in each tendon near its insertion. The articular surfaces of these sesamoids glide over articular surfaces on the plantar surface of the distal end of the first metatarsal bone. These articular surfaces are surrounded and lie within the joint capsule of the first metatarsophalangeal articulation. Between the sesamoids and protected by them runs the tendon of the flexor longus hallucis.

As regards the function of these bones, there is still some dispute, but they apparently act to distribute the weight to the distal end of the first metatarsal, and to protect the tendon of the flexor longus hallucis. Gillite believes that they play an important part in controlling all the movements of the big toe except extension, stating that the abductors and adductors are inserted into the sesamoids.

Clinically these sesamoid bones attracted no apparent attention until 1901, when Schunke reported the case of a laborer 40 years of age upon whose right foot a hard piece of clay weighing 100 kg. fell. Examination showed a division of medial sesamoid which was considered a fracture.

In 1904, Stieda in a study of the sesamoids of the hands and feet mentions the occasional occurrence of anomalous division of the sesamoid bones of the great toe, and calls attention to the possibility of mistaking these for fractures.

Marx, in the same year, reported the case of a man of 40 years who fell three feet upon the right foot, sustaining an injury about the plantar surface of the distal end of the first metatarsal, with pain, swelling, and tenderness on pressure. Examination showed division of the medial sesamoid of the right foot — not present in the left foot. The case was believed to be one of fracture, and operative removal of the fragments was recommended, but refused.

Muskat reported the case of a 50 year old patient who caught his foot in a hole. An examination discovered a T-shaped division of the sesamoid. He was treated by a protective shoe. Subsequent X-ray showed healing.

Grashey, in 1905, reported having seen a fracture, but gave no details.

Momburg, in 1906, reports two cases, one a soldier who after jumping off a springboard had sharp pain in the right foot, especially marked in the ball of the big toe on walking, with marked sensitiveness to pressure over the tibial sesamoid but with no pain on movement of the toe. Examination showed crossed division of the tibial sesamoid in the right foot. Similar finding also in the left foot; considered a congenital division. The second case was also in a soldier who complained of sharp pain under big toe after jumping off a wheel. Examination showed crossed division of the tibial sesamoid. Similar finding also in the left foot; considered a congenital division.

Momburg reviewed the previously reported cases and concluded that the cases of Marx and Schunke were examples of congenital division rather than fracture. Muskat's case was evidently one of true fracture. Momburg then reviewed a large number of radiographs and discovered nine cases of division of the sesamoids, five of these showing division into two parts, three into three parts and one into four parts. In the six cases in which both feet had been examined, the division was bilateral. The division was found to occur more frequently in the tibial sesamoid, and the line of division was usually transverse. Momburg believed the pain, swelling, and tenderness under the head of the big toe to be the result of an inflammatory reaction in the metatarsophalangeal joint.

Igelstein reports the case of a 22 year old student who slipped while skating. He suffered pain and tenderness in the region of the sesamoid with pain on strong dorsal extension. Examination showed a transverse division of the lateral sesamoid, believed by Igelstein to be congenital. The other foot showed division of the medial sesamoid.

Igelstein then entered into an exhaustive study of the subject and agreed with Momburg regarding the probable occurrence of congenital division in the cases reported by Schunke and Marx, but attempted to explain the clinical symptoms of pain, tenderness, and disability on the basis of a neuralgia excited by pressure of the partially dislocated portions of the sesamoid upon branches of the plantar nerves. He advocated rest and heat in treatment.

Stumme, in 1908, reported the case of a soldier who in running struck the end of his extended great toe against a pole. Examination disclosed a division of the sesamoid, and operation demonstrated the division to be a fracture. A second case occurred in a laborer whose foot was run over by a wagon. Examination showed fracture of the first phalanx of great toe and an irregular fracture of the medial sesamoid into three parts. Subsequent examination showed partial healing of the sesamoid. Stumme attempted to produce fractures on the cadaver and succeeded in so doing, both by direct and indirect violence.

Morian, in 1908, reported five cases of fracture of the sesamoid. One case fell four meters, sustaining a fracture of the tibial sesamoid. Another dropped a piece of marble on the left foot, resulting in a fracture of the tibial sesamoid and a fracture of the metatarsal; both subsequently healed. The third dropped a piece of iron on the right foot with resulting fracture of the first metatarsal and a small chip fractured from the sesamoid. Subsequent examination showed healing. The fourth case dropped a stone on the dorsum of the foot, sustaining a fracture of the second, third, and fourth metatarsals and a longitudinal fracture of the inner sesamoid. Subsequent examination showed healing of the sesamoid. In the fifth case, a wagon wheel ran over the left foot causing a fracture of the metatarsal and a fissure of the inner sesamoid. Healing also occurred in this fracture. None of these cases showed pain on motion — only tenderness to pressure.

Painter, in 1910, reports a case in a man of 66. The division was believed to be congenital, as it was present also in the other foot. It was relieved by the application of plaster and later by a leather-and-felt support which protected the tender area from pressure.

Müller, in 1912, reports the case of a woman of 35 who was injured two years before by having the foot trod on while dancing. The acute symptoms soon disappeared, but there remained a residual soreness and pain on walking. Examination showed slight tenderness over the sesamoid bone of the left great toe. The X-ray showed a transverse separation of the tibial sesamoid. Fragments were removed in June, 1911. The patient reported, in October 1911, that she was relieved of all pain and disability. No mention is made of the condition of the sesamoid of the other foot.

Speed, in 1914, reports, without details, the operative treatment of five cases of fracture of the sesamoids, with satisfactory results. He does not mention of the possible occurrence of congenital division, and the question arises as to whether these cases were true fractures or not.

Geist, in 1915, in a study of one hundred clinically normal feet found division of the sesamoid in 16 per cent.

From this brief review it is evident that a congenital division of the sesamoids may occur, usually involving the tibial sesamoid, and that after trauma, both direct and indirect, symptoms may occur which are identical with those seen after true fracture of these bones.

The experimental work of Stumme and of Morian as well as the case reports of Muskat, Stumme, Morian and Müller, definitely establish the occurrence of fracture of the sesamoids after direct and indirect trauma.

A suggestion offered by Igelstein to explain the occurrence of congenital division is that the sesamoids are formed by two centers which later fuse. A partial fusion results in the notched sesamoid noted by Mesbitt; a complete failure of union results in the divided sesamoids.

In all of these cases the common etiological factor has been trauma, either direct or indirect. The symptoms in all have been practically identical; pain beneath the distal end of the first metatarsal, greatly increased by pressure or by walking, some swelling, but practically no pain on movement of the big toe. After the acute symptoms have subsided, tenderness may persist for a considerable period, being excited by pressure over the sesamoid and by walking.

The symptoms occurring in the cases of congenital division have been explained by Momburg as the result of inflammation in the first metatarsophalangeal joint. The trauma presumably causes slight dislocation of the segments of the sesamoid with some resulting increase in mobility sufficient to keep up the low-grade inflammation. Igelstein does not accept this explanation, basing his objection on the ground that if the symptoms were dependent upon an arthritis there should be pain on movement of the joint. After rejecting localized inflammation of the tendon sheath and localized periostitis as possible causes, he concludes that the symptoms result from a neuralgia excited by pressure on the smaller branches of the plantar nerves by the displaced and abnormally movable parts of the divided sesamoid. This latter explanation is hardly satisfactory, and it seems probable that, as Momburg suggests, the symptoms are dependent upon an inflammation of the capsule of the metatarsophalangeal joint.

The differentiation between cases of congenital division and true fracture is often difficult, as the exciting trauma and the clinical manifestation may be the same in both. The X-ray in the fracture cases may show an irregular line of division between the fragments instead of the smooth line seen in the cases of congenital division. The line of division in the congenital cases is usually, though not always, transverse; in the true fracture it may be in various directions. In fracture by direct violence there is frequently fracture of the metatarsals or phalanges as well as of the sesamoid. The presence of division of the sesamoid of the other foot speaks against fracture. True fractures often show processes of repair in the course of time.

As regards the therapy, there is also a difference of opinion, some recommending rest and protection, others operative removal of the fragments. The cases of Muskat and Morian demonstrate that true fractures may heal with satisfactory results,— those of Momburg and Painter that the pseudofractures may be relieved without operation. Stumme, Müller, and Speed report satisfactory results in true fracture after operation, Speed recommending the removal of both sesamoids. No case of pseudofracture operated upon has been reported. It would seem advisable in handling these cases of either type to try rest and protection first, resorting to surgical removal only after this has failed.

During the last year I have seen four other cases showing division of the sesamoids.

One, Mr. J. P., a laborer, age 30, who struck the dorsum of the foot with a pick while standing on hard clay. This was followed by tenderness and pain beneath the head of the first metatarsal. X-ray showed crossed division of the medial sesamoid not present in the other foot. The patient was not relieved after five months of partial rest. The divided sesamoid was then removed. Examination of the bone showed no fracture. This was therefore a case of unilateral congenital division. The pain and tenderness have been relieved by the operation.

The second case, Mr. L., a middle-aged laborer dropped a barrel on his left foot. He complained of some pain in instep and under big toe. The X-ray showed transverse division of tibial sesamoid, present also in the other foot. Symptoms slight, and patient has not returned. Evidently a case of congenital division.

The other two cases are in women in whom division of the tibial sesamoid was found by accident. Both are evidently cases of congenital division.

In conclusion we may say:

1. That a congenital division of the sesamoid bones of the big toe is occasionally found, especially in the medial sesamoid.

2. That fractures of these bones may be produced by direct and indirect violence.

3. That direct or indirect violence applied to a foot with a congenitally divided sesamoid may give rise to signs and symptoms identical with those produced by fracture.

4. That true fractures may possibly be recognized by the more ragged appearance of the line of cleavage; the possible occurrence of other

fractures in metatarsals or phalanges; by the absence of division in the other foot; and, finally, by the appearance of healing. However, none of these points but the last is absolute.

5. That the symptoms in cases of congenital division probably result from an inflammation in the metatarsophalangeal joint.

6. That rest and protection will usually give relief; this failing, operative removal may be recommended.

7. That true fractures of the sesamoids will spontaneously heal with good clinical results. Satisfactory results are also reported after operative removal.

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6. IGELSTEIN. Deutsche Ztschr. f. Chir., 1908, xciii, 505.
7. STUMME. Fortschr. a. d. Geb. d. Röntgenstr., 1909, xiii, 312.
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CLOSURE OF RIGHT RECTUS INCISION

BY CHARLES R. ROBINS, M.D., F.A.C.S., RICHMOND, VIRGINIA

Professor of Gynecology, Medical College of Virginia; Surgeon, Stuart Circle Hospital; Chief Surgeon, Virginia Hospital; Gynecologist, Memorial Hospital

THE right rectus incision gives the most useful and varied exposure of the abdomen. In acute appendicitis the field is larger and greater freedom is offered for dealing with complications that are not infrequently present, such as an appendix with adhesions, an appendix in the pelvis or in other unusual positions that cannot always be ascertained previous to operation.

In chronic appendicitis with marked digestive disturbance, the necessity of exploring the gall-bladder, pylorus, and pancreas is generally conceded, and in certain other cases where a positive diagnosis cannot be made a general survey of the field is demanded. The right rectus incision is here a necessity, as well as in operations for frankly obvious disorders of the gall-bladder and stomach, malignant disease of the first half of the large bowel, and a number of other conditions unnecessary to mention.

The chief embarrassment in the employment of this incision consists in the difficulty of making a smooth and satisfactory closure of the wound. First of all there is a tendency for the intestines and omentum to bulge into or extrude from the wound as a result of respiration. If the abdominal contents are covered over with a gauze sheet the omentum and intestines are nevertheless pulled out when the sheet is withdrawn and are very difficult to replace. The use of various spoons and trowels is an improvement but is by no means satisfactory, for after these devices are withdrawn and before the wound is finally closed, protrusions often occur and are time-consuming and difficult to get back, to say nothing of the wear and tear on the surgeon's disposition.

Another problem is the tearing out of the suture used to close the peritoneum and the posterior sheath of the rectus. McArthur has called attention to this in an article in the January, 1915, number of SURGERY, GYNECOLOGY

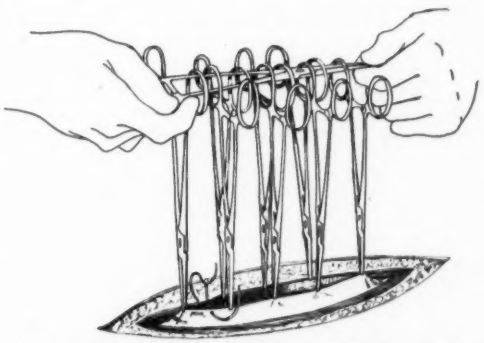

Fig. 1. Application of forceps, upward even traction and stitch started. Any amount of traction may be applied as the number of forceps distributes the pull and there is no danger of tearing out. Elevation of abdominal wall away from intestines prevents bulging and extrusion. When the abdominal wall lies flat on viscera, they act as a valve and each respiration forces them out.

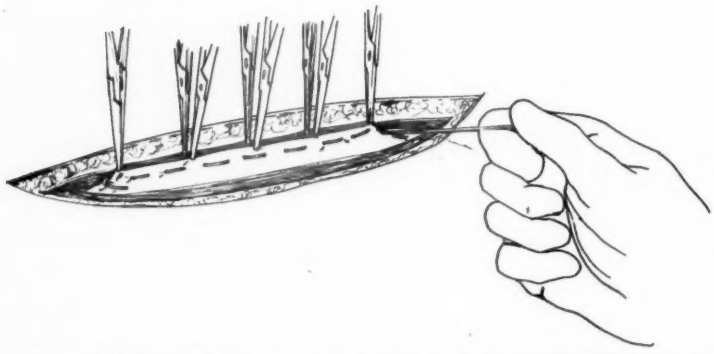

Fig. 3. Stitch completed and drawn taut. The even distribution of the pull acting on all points at one time prevents any tearing. (Peritoneal edges everted.) Stitches must not be placed too far apart.

AND OBSTETRICS. He explains it by the fact that fibers of the posterior sheath are derived from the transversalis muscle, which is largely concerned in the act of respiration and which makes a strong and rhythmic traction on these fibers after they have been divided. His suggestion of making the division of the fibers transversely instead of vertically in the line of the original incision is certainly a very ingenious one, but the incision thereby loses at once its chief value of wide exposure, and is restricted, as he says, to frank gall-bladder cases.

The method of the Mayos of including in every other stitch fibers of the rectus muscle prevents to an extent this cutting out, but in certain cases, particularly in elderly women who have borne many children and in whom the muscles are attenuated and softened, we often see these stitches pull right through, the tissue offering no resistance whatever. Many of these cases are undoubtedly closed with very poor or no approximation of the peritoneum, with the omentum caught in the wound, and with a wide raw surface lying against the abdominal contents. As a result of this there is some disposition to hernia, and certainly in a very large number of cases there are adhesions to the abdominal wall that no doubt explain much of the pathology and unsatisfactory results which sometimes follow operations in which this incision is employed.

For some time I have been working on a technique for closure that will obviate these various defects, and the method which I am now using is shown by the accompanying illustrations.

Step one. A straight Ochsner forceps is applied at each end of the incision and three on each side which grasp firmly the peritoneum and the posterior sheath of the rectus. By making firm even traction upward, equally distributed among all the forceps, there will be no tearing of the tissues as there would be if one or two forceps were pulled on at a time. Sufficient traction can then be made to lift the abdominal wall entirely away from the contents so that there will be no bulging or extrusion into the wound. The essential point is the distribution of the pull over eight pairs of forceps so that the strain is

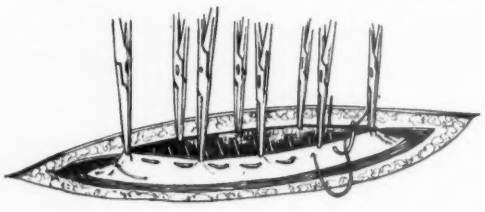

Fig. 2 Continuous mattress suture nearly completed.

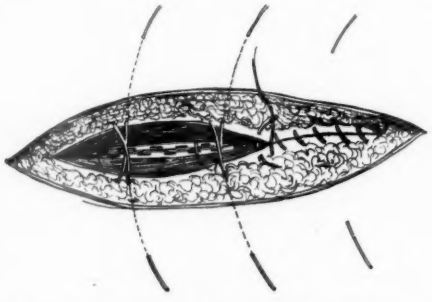

Fig. 4. Introduction of silkworm-gut suture and completion of catgut suture.

divided among them all. The traction must therefore be made evenly on all the forceps. This can be accomplished either by the assistant's holding them in his hand or by threading the rings of the forceps on another pair of forceps held horizontally. In this latter case the ring pointing over the wound should be used, and the forceps should be threaded on alternately, first from one side and then from the other. In this way the forceps act on an easy pivot and the act of pulling upward has a tendency to pull the edges of the wound together.

Step two. Introduction of suture. While traction is being made, the suture is fixed at the upper angle by taking a bite in the sheath above the forceps attached in the upper angle of the wound and tying at this point. A continuous mattress suture is then passed back and forth across the wound, in each case taking out all the slack in the stitch but never making any tension. If tension is made on any loop singly it may pull out. After the stitch has been placed for the entire length of the wound in this manner and while upward traction is made on the attached forceps, the suture is drawn taut by pulling on the end, while the assistant detaches the forceps that have been used for making traction upward. The same principle applies here in that the distribution of traction by suture, being applied simultaneously at all points of penetration for the whole length of the incision, makes the edges come snugly together without any tearing out, and at the same time the peritoneal margins are everted so that there are no raw surfaces exposed toward the abdominal contents for formation of adhesions. The catgut suture likewise is not exposed in the peritoneal cavity.

Step three. The wound is then closed in the usual manner, silkworm-gut sutures are introduced in figures-of-eight, the lower loop passing through muscle as well as fascia and also including the everted edge of the peritoneum and posterior sheath of the rectus. The continuous catgut suture used for closing the peritoneum is used for uniting the fascia and the fat; the skin is closed with a subcuticular stitch of silkworm-gut and then all the figures-of-eight stitches and the ends of the subcuticular stitch are tied over a gauze pad. This latter prevents the stitches cutting into the skin and adds greatly to the comfort of the patient.

I have used this method of closure in the most difficult cases and have yet to experience a failure. I believe its employment will remove the chief embarrassment experienced in employing the right rectus incision.

BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

A Reference Handbook of the Medical Sciences Embracing the Entire Range of Scientific and Practical Medicine and Allied Science. Third edition, revised and rewritten. Edited by Thomas Lathrop Stedman, A.M., M.D. New York: William Wood & Company, 1915.

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The Next Generation. By Frederick A. Rhodes, M.D. Boston: Richard G. Badger, The Gorham Press.

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BOOK REVIEWS

A CRITIQUE OF NEW BOOKS IN GYNECOLOGY AND OBSTETRICS

By GEORGE GELLHORN, M.D., St. Louis, Missouri

TWO noteworthy additions to our gynecological library came to us from Germany a short time before the cataclysm in Europe engulfed all other interests. The first of these two books[1] deals with the pathologic anatomy and histology of the female genital organs. Of this work the reviewer can speak only in words of highest praise. It does not often happen in these days of literary overproduction that a book answers a crying need. The book before us holds this distinction. The first and only modern treatise on gynecologic pathology was published by Gebhard in 1899. His untimely death prevented the author from revising his book and bringing it up to date. It was left to Frankl in 1914 again to treat of this subject and to embody in book form the numerous additions to our knowledge and changes in our conceptions of pathologic processes in the female genital sphere that have taken place in the last fifteen years — a difficult undertaking if we consider that the material lay scattered in innumerable books and single reports. To collect and critically analyze this almost overwhelming mass of evidence required not only a complete familiarity with the literature but also extensive personal experience and mature judgment, all of which have enabled the author to present his studies within the small compass of 300 pages.

The subject matter is arranged according to organs and includes not only pathologic alterations but also malformations. To choose a few illustrations: The discussion of the so-called glandular endometritis (p. 27) is based upon the researches of Hitschmann and Adler. A hyperplastic endometrium occasionally may become inflamed like any other mucosa but under no circumstances is hyperplasia the result of inflammation. Nor are cervical polypi of inflammatory origin. Inflammatory changes in polypi, if present, are secondary in character (p. 34). The appearance of cylindrical epithelium upon cervical erosions signifies to Frankl the beginning of healing (p. 35). Metritis is a misnomer in so far as it represents a hyperplasia of the muscularis, not an inflammation (p. 26). Contrary to von Recklinghausen, Frankl ascribes the origin of adenomyoma to remnants of the wolffian body only if the tumors are located in the uterine horns (p. 52). Membranous dysmenorrhœa is still an obscure condition; inflammation, however, may be excluded as an etiologic factor (p. 39). Frankl denies the persistence of menstruation in pregnancy; there may be bleeding at menstrual dates in pregnancy, but no true menstruation (p. 111).

The histology of hydatiform mole (p. 122) and its relation to chorio-epithelioma (p. 143) receives careful consideration. The cells of malignant chorio-epithelioma possess all the destructive qualities of normal chorionic cells in the first weeks of pregnancy. But, while under normal conditions the serum of pregnant women dissolves chorionic cells when they enter the maternal circulation, the blood of women with chorio-epithelioma has lost its syncytiolytic quality. Cases of spontaneous cure of chorio-epithelioma may, therefore, be explained by a timely return of this biochemical property.

A hydrosalpinx need not always be of gonorrhœal origin, as is usually assumed. Frankl has found in such a tube staphylococci in pure culture (p. 160). Any salpingitis may heal eventually, but after severe inflammation *restitutio ad integrum* is inconceivable; the fibrous thickening of the walls of the tube, peritonitic alterations, and tubal occlusion prevent a complete return to normal conditions (p. 162). Abdominal pregnancy is generally supposed to be secondary to tubal gestation. Frankl, however, is inclined to believe also in a primary insertion of the ovulum upon the peritoneum (p. 173). Cystic degenerations of the ovary are to be considered as retention cysts (p. 194), and the term oöphoritis should be restricted to actual inflammation due to bacterial invasion (p. 188). The histogenesis of pseudomucinous cystadenomata of the ovary is still unsolved (p. 204). Frankl does not accept Pfannenstiel's theory of their origin from follicular epithelium and would rather classify them as congenital teratogenous new-growths.

From these few selections, taken at random, the wealth of instruction and stimulating thought one receives in studying this book may readily be inferred. The diction is simple and direct and will offer but slight difficulty even to those only moderately well versed in the German language.

Moreover, the benefit is greatly enhanced by an abundance of most excellent pictures, both macroscopic and microscopic. The latter, in particular, may be declared flawless. These colored reproductions are so perfect that their inspection through an

[1] Kurzgefasstes Handbuch der gesamten Frauenheilkunde, Gynäkologie und Geburtshilfe für den Praktischen Arzt. By Dr. W. Liepmann. Volume II. Pathologische Anatomie und Histologie der weiblichen Genitalorgane in Kurzgefasster Darstellung. By Oskar Frankl. Leipzig: F. C. W. Vogel, 1914.

ordinary magnifying glass renders a microscope unnecessary. Good illustrations are, indeed, one of the most important means of instruction and should be demanded of any book that purposes to teach.

The book, as is customary, is dedicated to the use of the general practitioner, but this object will, I fear, remain a pious wish. Only the last generation or two of young physicians have been taught to regard pathology as the foundation of all their medical knowledge. The majority of general practitioners consider pathology and what the microscope may reveal more as a sort of scientific bric-a-brac, but the ideal practitioner of the future will perhaps recognize that a personal understanding of histologic changes is as indispensable to him as the lessons learned from the thermometer or the stethoscope in other fields of medicine.

In the meantime, every gynecologist and every pathologist will rejoice in possessing and freely consulting a book the merit of which can not be questioned. The publishers deserve our thanks for bringing out so splendid a book, and we may generously overlook the heavy and glossy paper so commonly used in German scientific works instead of the light and pliable paper which constitutes one of the chief attractions of British publications.

For the sake of making this work accessible to a very large circle of readers, it is to be hoped that an English translation will soon be forthcoming.

THE second book[1] is a heavy tome of 823 pages, with 19 colored plates and 115 illustrations. It has been written by two authors, Ludwig Fraenkel and Rudolf Theodor Jaschke, and is divided into two large sections entitled respectively: "Sexual physiology of woman in health and disease" and "Physiology and pathology of labor."

The arrangement of the 17 chapters may convey a preliminary idea of the contents of this volume. The first six chapters deal with the formation and maturation of the follicle, ovulation and internal secretion of the ovary, sexual instinct and its gratification, conception, formation of the decidua and nidation of the ovulum, and finally, the physiology and pathology of pregnancy together with the normal and pathologic physiology of the membranes and the amniotic fluid. Chapter vii treats, in about 220 pages, of the physiology and pathology of labor. Puerperium and lactation are discussed in Chapters viii and ix, while the two following chapters are devoted to the physiology and pathology of menstruation. Chapter xi deals with childhood, puberty, and climacterium. Chapter xii presents facts and theories regarding the determination of sex. In Chapters xiii and xiv the relations of the glands with internal secretion to the genital function and the special activity of the ovarian secretion are put before us. The physiology of the genital tract from the tube down to the vulva is dealt with in Chapter xv, and the relation of the sexual function to other organs is given in Chapter xvi. The concluding chapter offers an outlook upon the finer relations between sexual physiology and tumor formation.

In this bewildering richness of material a few leading principles soon became apparent.

To begin with, there is the general scheme, a discussion of pathologic functions in close connection with normal functions. Cohnheim, in his "General Pathology," has defined disease as the peculiar, i.e., abnormal, course of the same processes which represent the manifestations of life in the healthy organism, and Krehl, some ten years ago, embodied in his "Pathologic Physiology" the problems that confront the medical clinician. In the book before us we find a similar principle applied to gynecology and obstetrics.

The usual division into gynecology and obstetrics is, however, abolished in this book. Gynecology, in a wider sense, comprises both branches, just as in actual practice they merge into one another. Pregnancy with all that appertains thereto is but one of the phases of woman's life and the functions of her genital organs, and we find in the book a consistent effort to treat it as such.

The influence of recent biologic studies upon our special field is comprehensively discussed. More than ever before have analogies with animal physiology been taken into consideration. In fact, the reference to biologic phenomena can be traced like a red thread throughout Fraenkel's treatise. Himself an authority on the subject, the writer is the competent man to develop for us the all-important significance of the glands with internal secretion in the sexual sphere of woman, and while we are made to realize that only a beginning has been made, yet a wide outlook opens before our eyes and exerts a stimulating effect upon our thoughts.

That gynecology is more than a mere surgical specialty must have become apparent from the foregoing appreciation, and this principle, with which the reviewer is in hearty accord, justifies the inclusion in this book of such questions as determination of sex, development of secondary sexual characters, sexual psychology of woman, education of girls, selection of vocations, influence of clothing and of sport upon the genital function, etc.

In the chapter on physiologic and pathologic labor written by Jaschke the application of physical principles upon the process of parturition represents the dominant note. The teachings of Sellheim are given just preëminence and, in addition, the literature of the world is well utilized.

After these remarks, necessarily brief and incomplete though they are in order not to exceed the scope of a book review, it seems superfluous to point out particularly interesting details such as present themselves almost on every page, and only a very few selections may here follow.

[1] KURZGEFASSTES HANDBUCH DER GESAMTEN FRAUENHEILKUNDE GYNÄKOLOGIE UND GEBURTSHILFE FÜR DEN PRAKTISCHEN ARZT. By W. Liepmann. Volume III. Normale und pathologische Sexualphysiologie des Weibes, by Ludwig Fraenkel. Physiologie und Pathologie der Geburt, by Rud. Th. Jaschke. Leipzig: F. C. W. Vogel, 1914.

Ovulation, according to Fraenkel (and others), occurs approximately between two menstruations, and very likely is the cause of the so-called *Mittelschmerz*, the etiology of which had heretofore not found a satisfactory explanation (p. 10). The time of occurrence of ovulation must, also, influence our views regarding the duration of pregnancy, which lasts from 10 to 14 days less than previously assumed (p. 170). The frequency of small cystic degeneration of the ovaries should, in the absence of other tangible causes, be attributed to sexual irritation (p. 14). The corpus luteum is formed within three days after ovulation and is derived from epithelial cells of the membrana granulosa (*glande epithéliale* of the French). In addition, there is formed an interstitial gland from connective-tissue elements of the theca interna; this gland, while very prominent in animals, is only rudimentary in the human species (p. 32).

As a result of fourteen years of experimental research, Fraenkel formulates a "corpus luteum law" as follows:

1. The corpus luteum produces in the endometrium premenstrual changes which are indispensable for the nidation of the ovulum: the *proœstrum* (p. 108).

2. This function of the corpus luteum is not limited to one cycle of four weeks but persists throughout the age of reproduction as the corpora lutea closely follow one another. Their totality represents a distinct new organ: the glandula lutea which supplies a constant stimulation that prevents the genitalia from retrogressing into the infantile or progressing into the senile stage. If the *proœstrum* is the single function, the total turgor of the years of reproduction is the permanent effect of the corpus luteum (p. 531).

Menorrhagia is due to hæmophilia more often than is usually assumed (p. 540). Hyperplasia of endometrium and endometritis cause increase of discharge, but not bleeding (p. 541). The indiscriminate use of the curette is properly stigmatized, always by referring to biologic factors which are at fault (p. 549). The therapeutically efficient agent of the pituitary body is very likely contained, not in the posterior lobe, but in the intermediate part (p. 662).

But enough of such details. It must already be obvious to the reader that we have to deal with an unusual book — let me add, a most interesting and fascinating book — in which an experienced physician and carefully observing scientist speaks to us. That not every one of his views meets with our approval, does not constitute an unfavorable criticism. That in some of the theories advanced the exact scientific proof is still outstanding, is admitted by the author himself; yet we must agree with him that a working hypothesis is better than none at all.

There is no fault to be found in the book as such that I can see, but I believe that it altogether misses the purpose for which it was written. Its title proclaims it for the use of the general practitioner. What was said above in this connection of the book of Frankl is even more true in regard to the work by Fraenkel and Jaschke. Why are all medical books inscribed to the general practitioner? There should be a closed season in books for the poor, overworked general practitioner so that he may find time now and then to look over his reference books of his medical school days. No, *this is a book on gynecology for gynecologists* and it should be studied most earnestly by all who profess this specialty.

These two books, a review of which has been attempted in the foregoing, form the second and third volumes respectively of a new work edited by W. Liepmann, of Berlin, under the title: *Short Handbook of the Entire Gynecology.* The seven volumes of which this "short" handbook is to consist prove the title to be a misnomer, but if the other volumes come up nearly to the standard set by the two forerunners, we might well overlook the *lapsus linguæ* and look forward to the completed set with eager anticipation. The combination of gynecology and obstetrics within the bounds of one work has previously been attempted by a few authors at an earlier stage of development of our specialty. The idea is very attractive; but it has this disadvantage, that repetitions are unavoidable. The announcement of the publishers gives a long list of names of collaborators. In other words, there will be in these seven volumes a number of monographs and these are bound to present differences of views. This would be a drawback were the work to be perused by the general practitioner; but as I believe that it will be read mainly by specialists whose personal experience will enable them to study it critically, this apparent disadvantage will prove only an additional attraction.

Clinical Congress of Surgeons of North America

SIXTH ANNUAL SESSION

BOSTON

OCTOBER 25 TO 29, 1915

CLINICAL CONGRESS OF SURGEONS OF NORTH AMERICA

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THE CLINICAL CONGRESS OF SURGEONS IN BOSTON

The sixth annual session of the Clinical Congress of Surgeons of North America, to be held in Boston the week of October 25, 1915, will be conducted along the same general lines as previous sessions of the Congress in the United States except that, following the precedent established at the fifth session held in London in July, 1914, the number in attendance will be limited. A careful survey has been made of the operating amphitheaters, lecture rooms and laboratories of the several medical schools and hospitals which are coöperating, by the Boston committee on arrangements to ascertain exactly the number of visiting surgeons that can be comfortably cared for at all times and the limit of membership fixed in accordance therewith. There will be a place for each surgeon who receives a membership card. Advance registration is therefore required. At this date the membership list for the Boston session is nearly complete. A formal receipt is mailed to each member upon payment of the registration fee, which receipt is to be exchanged for a membership card upon presentation of the receipt when registering at headquarters during the session. When the registrations have reached the required number no further cards will be issued.

SPECIAL TICKETS

The use of special tickets at previous sessions has fully demonstrated the efficacy of this method of providing for the distribution of the visiting surgeons among the various clinics and demonstrations, preventing overcrowding, as tickets for any one clinic or demonstration are limited in number to the actual capacity of the room in which the clinic or demonstration is to be given. Special tickets will be issued for all clinics and demonstrations, and will be distributed daily at headquarters after the clinical program for the day has been posted on the bulletin boards.

HEADQUARTERS

Headquarters will be established at the Copley-Plaza, Boston's newest hotel, which is centrally located in the Back Bay district and from which

any of the hospitals and medical schools can be reached in a few minutes. The hotel is located only a block and a half from the Back Bay and Huntington Avenue railroad stations. The Congress headquarters will be on the ground floor of the hotel where there is ample space for the registration and ticket bureaus, bulletins, etc. The large ball room in which the evening meetings are to be held is also located on the ground floor.

REGISTRATION FEE

The constitution of the Congress provides that a registration fee shall be required of each member attending an annual meeting. There are no annual dues. The registration fees provide the funds to meet the expense of preparing for and conducting the annual meetings so that no financial burden is imposed upon the members of the profession in the city entertaining the Congress.

CLINICAL PROGRAM

The schedule of clinics and demonstrations as published in these pages is a provisional one, and is to be rearranged and amplified during the weeks previous to the Congress. The real program of the Congress is the schedule of clinics and demonstrations which is posted each afternoon on the bulletin boards at headquarters giving in detail the cases to be operated on or demonstrated at each clinic.

The committee on arrangements has planned that there shall be a complete showing of Boston's clinical facilities in every department of surgery, including gynecology, obstetrics, genito-urinary surgery, orthopedics, and surgery of the eye, ear, nose and throat. In addition there will be a series of demonstrations and lectures on borderline subjects given by a number of eminent Boston surgeons and internists.

HOTELS

The executive committee is informed that the Boston hotels are usually well filled at this season of the year, and would strongly urge members to make their hotel reservations at once. Other first-class hotels in the vicinity of the Copley-Plaza (the headquarters) are: The Lennox, Brunswick, and Victoria.

EVENING MEETINGS

The Executive Committee of the Congress has arranged for meetings on four evenings of the week. The presidential meeting will occur on Monday evening, at which time the President-elect, Dr. Charles H. Mayo, will deliver the annual address. On Tuesday, Wednesday and Thursday evenings there will be two meetings, one for the section on general surgery, the other for the section on surgical specialties. The principal papers will be read by visiting surgeons and will be discussed by Boston surgeons.

REDUCED RAILWAY FARES

On account of the Boston meeting the railways in the eastern portions of the United States and Canada have granted certain reductions in fares in selling round trip tickets. In the eastern part of the United States the fare will be two cents per mile in each direction, going and returning via the same route only, and over which one-way tickets are regularly sold. This rate will be in effect in the territory covered by the railway lines in the New England Passenger Association, Trunk Lines Association, Southeastern Passenger Association and Central Passenger Association, which covers practically all of the states east of the Mississippi River. Members living in the Western Passenger Association territory, that is, west of Chicago and St. Louis, should purchase tickets to the above gateways and then repurchase a round trip ticket to Boston in order to avail themselves of the special reduced fares. In Canada practically the same rates prevail as far west as Port Arthur. Tickets will be sold from all points on October 22, 23 and 24 with a final return limit to reach one's original starting point on or before midnight of November 3.

THE MEDICAL SCHOOLS AND HOSPITALS OF BOSTON

IV. A Group of Boston's Public Hospitals

MASSACHUSETTS GENERAL HOSPITAL

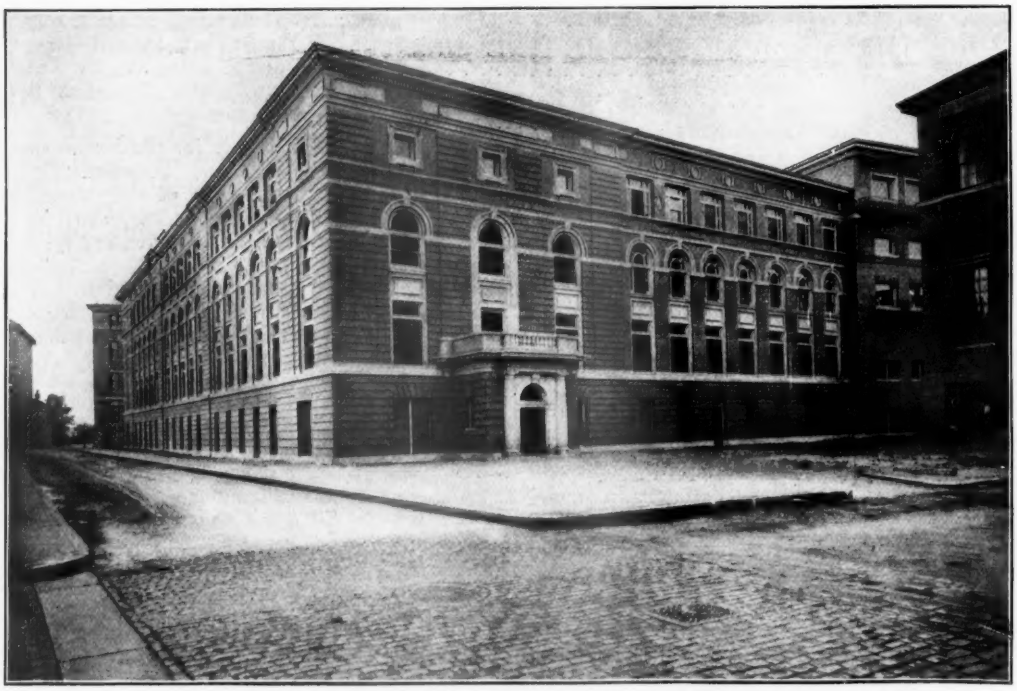
In 1810, Dr. John Collins Warren, nephew of Joseph Warren who fell at Bunker Hill, and Dr. James Jackson signed a letter which set forth the need of the proposed Massachusetts General Hospital and which really began the foundation of the hospital. After detailing the proposed services to the poor, and stating the advantages for medical education, the letter ended with an appeal just as urgent now as it was then: "To what other objects can the superfluities of the rich be so well bestowed?"

The following year, 1811, the General Court of Massachusetts granted a charter for the projected hospital. From the beginning, the enterprise was intended to care for the insane as well as the acutely sick and wounded. On July 4, 1818, the corner stone of the present hospital was laid and patients were admitted in 1821, with Dr. Jackson and Dr. Warren as physician and surgeon in charge.

In 1846, ether was first administered to full surgical anæsthesia in the hospital and in commemoration thereof the following inscription appears in the dome of the hospital:

> On October 16, 1846, in this room, then the operating theatre of the hospital, was given the first public demonstration of anæsthesia to the extent of producing insensibility to pain during a serious surgical operation. Sulphuric ether was administered by William Thomas Green Morton, a Boston dentist. The surgeon was John Collins Warren. The patient

Massachusetts General Hospital, Bulfinch Building.
In the Dome of This Building Ether was First Given to Full Surgical Anæsthesia October 16, 1846.



Massachusetts General Hospital, Out-Patient Building.

declared that he had felt no pain during the operation and was discharged well December 7th. Knowledge of this discovery spread from this room throughout the civilized world. And a new era for surgery began.

The contrast between the number of patients in the early days and those treated last year is interesting. By gradual growth, the facilities of the hospital, by means of 333 beds last year, enabled the physicians and surgeons to care for 6,712 patients in the wards. The number of visits in the out-patient department was 158,090, or an average daily attendance of 520 patients.

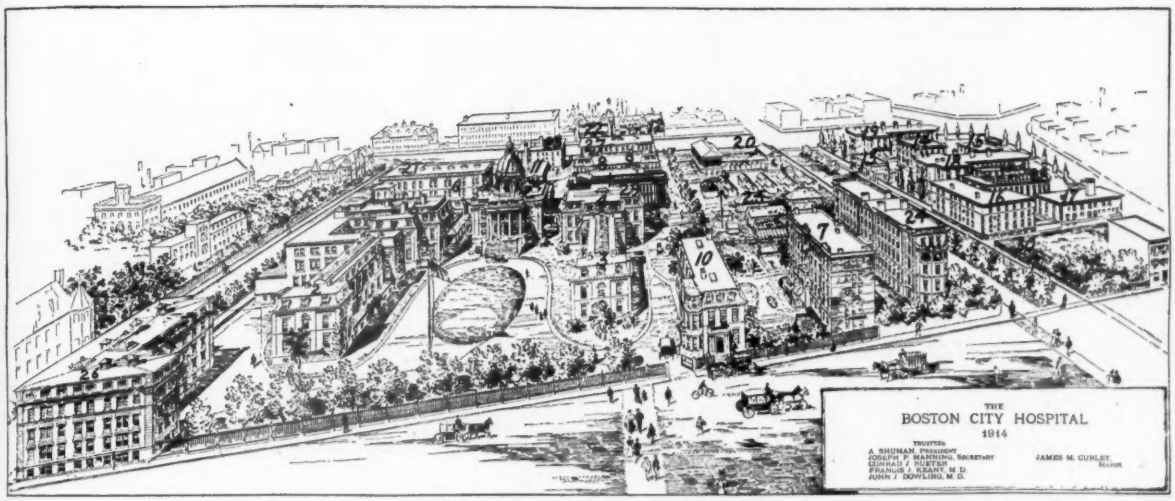
The hospital beds are divided among two medical and two surgical services, an orthopedic service, a genito-urinary service, and throat and skin services. The south medical department, which treats syphilis alone, has four beds at its disposal. In connection with the out-patient department there is a hydrotherapeutic department and a medicomechanical department for the treatment of chronic lesions of the muscles and joints by means of apparatus.

The hospital is not in any way a state institution. It is supported solely by voluntary gifts and the receipts from those patients who pay board.

Every institution has its own particular points of interest. At the Massachusetts General Hospital the thorough care of patients who have been treated in the wards is carried on by the follow-up system. This means that at the end of a year, each surgical ward patient is requested to return for an examination, and the results of his hospital treatment noted. This idea is extended so that a patient is sent for if he does not keep his appointment for treatment and if the treatment is unsuccessful for one reason or another, the home surroundings or other sources may be surveyed.

The relation of occupation to disease has received considerable attention. Future legislation in connection with occupations and occupational diseases will doubtless be guided by such statistics.

The Social Service, which is a pioneer in this line of endeavor, gives invaluable assistance to the staff and the social history supplementing the medical, enables the physicians to accomplish better results.



Birdseye View of Boston City Hospital.

A cement shop to enable needy handicapped patients to tide over the period of incapacity and discouragement, has proved its value as a source of livelihood and moral encouragement to the workers.

To one interested in administrative problems there are several matters of interest, such as the methods used to eliminate waste by washing and resterilizing used gauze and bandages; inspection of garbage; ward and kitchen inspections; appliances and methods employed to reduce noises in a hospital; manufacture of picked cotton from discarded white goods.

BOSTON CITY HOSPITAL

The Boston City Hospital was dedicated May 24, 1864. At that time it consisted of three buildings; at the present time there are forty-six. These buildings occupy 30⅓ acres and the total valuation of land and buildings is $3,586,100. The hospital controls more than 1,000 beds, which are divided among the medical, surgical, gynecological and genito-urinary services, and a department for the treatment of scarlet fever, measles and diphtheria.

In addition to the above mentioned departments, the hospital has a large out-patient department, a convalescent home, and relief stations designed for caring for acute emergencies at Haymarket Square and in East Boston. The pathological laboratory, under Dr. Mallory, and the X-ray department, under Dr. Williams, are noteworthy.

During the year ending January 31, 1914, 18,077 house patients were treated at a cost per patient of $1.81 per day. In the same year,

Boston City Hospital, South Department, Contagious Diseases.

Boston City Hospital, East Boston Relief Station.

Boston City Hospital, Haymarket Square Relief Station.

98,652 out-patients were treated. There are 103 members of the medical and surgical staff and 42 house-officers.

The department for contagious diseases (scarlet fever, diphtheria, and measles) is known as the South Department. In 1888 separate wards were set aside for these diseases, but these accommodations soon proved inadequate and in 1895 the South Department was opened. This department, although an integral part of the hospital, is an entirely separate department. It was in these buildings that Dr. John McCollom demonstrated the value of antitoxin in the treatment of diphtheria, and reduced the death rate from 38.10 in 1894 to 9.48 in 1913. The department is now directed by Dr. Edwin H. Place.

The Gynecological Department is distinct from the surgical services; it controls 60 beds and has two operating rooms for its own use.

The City Hospital is affiliated for teaching purposes with the Harvard Medical School and with Tufts College Medical School. The students work both in the out-patient department and in the house.

BOSTON LYING-IN HOSPITAL

The Boston Lying-in Hospital was established in 1833 and reopened in 1873 in the buildings which it now occupies. It embraces the length of McLean Street, No. 4 being the pregnancy clinic, No. 6 the nurses' home, No. 16 the administration building and No. 24 the hospital itself. During the year 1914, the hospital cared for 789 mothers and 782 babies. The out-patient department attended 1,944 mothers and 1,961 babies.

In 1910 there was organized a pregnancy clinic

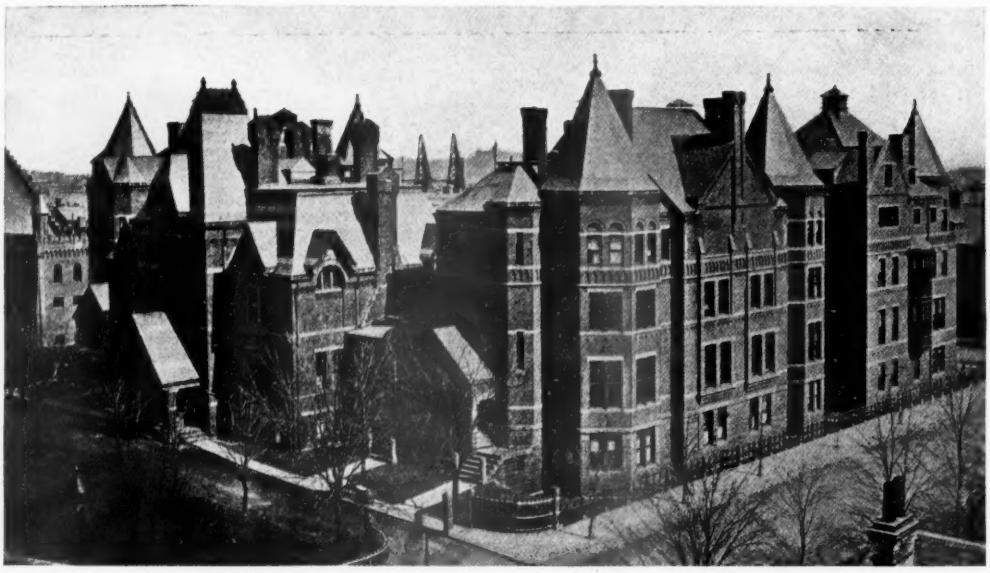
Boston Lying-In Hospital.

Massachusetts Homeopathic Hospital, the Robert Dawson Evans Memorial Research Building.

to care for those women intending to enter the hospital or its out-patient department. The hospital was a pioneer in initiating institutional systematic medical supervision of pregnancy and the benefits have been educational and far reaching. The number of patients entering this clinic during 1914 was 1,799, who made a total of 4,562 visits. Of these patients 1,487 were delivered in the hospital or the out-patient department and 1,418 were discharged as well. The chief object of the pregnancy clinic has been not alone the prevention, early detection, and amelioration of the various complications of pregnancy, but to promote maternal general good health that mothers may go to full term, bear living children and suckle them at least during their early months.

The Training School for Nurses was formally established in 1888. Since that date 535 nurses have been given diplomas by the hospital, the latest graduating class numbering 35. The school is so arranged as to admit for different terms both those who have graduated from the training schools of approved general hospitals and others who have had less hospital or other experience in nursing.

To meet the demands for increased room and equipment land has been purchased on the corner of Avenue Louis Pasteur and Longwood Avenue, opposite the Harvard Medical School, looking toward the erection of a new and larger hospital with out-patient department branches in the north and west ends of the city. Such a hospital, to meet present enlightened opinion, providing all the modern facilities for the care of women in labor and making provision for the medical and surgical care of all the complications of pregnancy and early infancy, and of the infections, injuries, and neoplasms incident to childbearing, will maintain a woman's clinic at least equalling institutions such as the Dublin Rotunda, the infirmaries of Edinburgh or Glasgow and the Frauenkliniks of Dresden and other German cities.



Massachusetts Homeopathic Hospital, Main Building.

MASSACHUSETTS HOMEOPATHIC HOSPITAL

The main part of the Massachusetts Homeopathic Hospital is located on East Concord Street, between Harrison Avenue and Albany Street, on land adjoining the Boston City Hospital. It was incorporated by act of the state legislature in 1855, but it was not opened for the reception of patients until 1871 when it occupied modest quarters at 14 Burroughs Place, its capacity at that time being 16 beds. In 1871 it was moved to East Concord Street, its present location, where it had one building with wards capable of caring for 40 patients. Steadily with the passing years it has increased in size by the addition of wings, annexes, and new buildings, until at the present time its capacity is in excess of 450 beds. The hospital has from the first been supported by private subscriptions, endowment funds and receipts from paying patients, although in 1890, for the purpose of building a medical wing and a surgical annex, it received an appropriation from the state. Its total running expenses during the year 1914 reached the sum of $251,145.00, and its holdings including real estate and endowments amounted to about $2,500,000.00.

The hospital in its entirety consists of a main group of buildings wherein are treated medical, surgical, obstetrical, orthopedic, nose and throat, and eye and ear cases, the equipment including also facilities for up-to-date X-ray work and electro-therapeutics; of the Evans Memorial Department for Preventive Medicine and Clinical Research with its special laboratories, clinical and educational facilities; of the new and enlarged maternity and out-patient department now under construction; of the Nurses' Home; and of the special building known as the Clark Ward for Children. In addition the John C. Haynes Memorial for Contagious Diseases is located in Brighton, a home for convalescent women and children in Watertown, and one for convalescent men in Dorchester.

In the hospital there were treated during the year 1914 a total of 7,327 in-patients, as against 2,284 in 1900, 683 in 1890, and 190 in 1880, and more than 12,000 out-patients were treated during the year just passed. A total of 3,147 operations were performed in the surgical department, 919 of which were abdominal. There were 1,059 confinement cases in the maternity department, with 31 cæsarean sections.

The routine pathological work is done in the laboratories of the adjoining Boston University School of Medicine, and included in 1914, 721 tissue examinations and 5,898 "clinical examinations" besides thousands of urinary analyses.

Massachusetts Homeopathic Hospital, the New Maternity and Out-Patient Building.

The services of ten internes are utilized. Each forenoon, throughout the school year, the wards and operating-rooms of the hospital are open to the senior students of Boston University School of Medicine for clinical training and experience.

BOSTON DISPENSARY

The Boston Dispensary was established in 1796, when Boston had a population of 20,000. During the first year it cared for eighty patients; last year for about 40,000. It provides medical care for the sick in the following ways:

1. Out-patient clinics at 25 Bennet Street, receive approximately 110,000 visits annually from over 30,000 patients. Twelve clinical departments, including clinics in general medicine for adults and for children, clinics in surgery, and in all the recognized specialties, are included in the dispensary. All clinics are open during the morning at the same time, so that special opportunities are provided for team-work in diagnosis, involving as it often does personal consultation among departments. Instruction is given to students of the Harvard Medical School and the Tufts College Medical School, and various courses for graduates in medicine are offered by members of the staff who are connected with Harvard Graduate School. Patients unable to afford adequate medical service are admitted to the morning clinics on the payment of nominal fees, usually 10 cents or when necessary, as is often the case, without charge.

Certain clinics have been established in the evening to meet the need of working people who can not attend clinics in the daytime without loss of wages. At these evening clinics a charge of 50 cents a visit is made. The medical service is salaried. Evening clinics include at present, departments for eye diseases (men and women), genito-urinary diseases (men only), and syphilis (men and women).

2. District physicians are sent to treat acutely sick patients in their homes throughout the city of Boston. No service of this character is provided by the municipality, the Boston Dispensary having furnished it since its foundation. About 8,000 patients are cared for annually, nursing service being provided by the Instructive District Nursing Association of Boston.

3. The Hospital for Children, with twenty-five beds, supplements the unusually large children's service of the dispensary, which includes twelve to fifteen thousand individual patients a year. A

Boston Dispensary.

system of following-up patients for the double purpose of providing needed care after discharge from the ward, and for informing the staff as to the results of treatment is maintained.

4. Medicine is dispensed by the pharmacy which is open every day in the year, furnishing 93,000 prescriptions during 1914.

5. A Social Service Department, including eleven salaried workers, a number of students, and many volunteers, assists the medical staff in the out-patient clinics and in the Hospital for Children in making treatment effective when disease is complicated by social problems such as poverty or ignorance. Through affiliation with the Boston School for Social Workers students are given a systematic course of training leading to a diploma in medical-social service.

6. The study of standards and methods of dispensary service is systematically pursued by members of the medical and executive staffs of the Boston Dispensary, including studies of the medical results of out-patient treatment in various diseases and modes for testing the efficiency of hospital and dispensary service.

7. Publications: The annual reports of the Boston Dispensary in which much space is devoted to study of methods and results are sent to any address on request without charge. A series of articles has been issued, dealing with various phases of the standards, methods, and results of out-patient service, which is likely to be of interest to medical staffs, administrators, or trustees of hospitals and dispensaries. Lists of these publications are furnished free on request and the publications themselves at cost price.

BOSTON STATE HOSPITAL

This institution, conducted by the state, is for the care and treatment of the insane from the city of Boston. All classes of mental cases are received. The present capacity is 1,450 beds. The medical staff numbers seven, exclusive of the superintendent and the pathologist. There are 203 nurses and attendants, the employees numbering 329. A training school for nurses is maintained; also a social service department.

The hospital was established by the city on another site in 1839; it was moved to the present location in 1893–95, and was taken over by the state in 1908, since which date buildings have been added doubling its capacity. The site, 232 acres, is partly in Dorchester and partly in West Roxbury District, bounded by Austin, Canterbury, Walk Hill, and Harvard Streets and bisected by Morton Street, on either side of which lie the East and West Groups, the former a reception and treatment division, the latter devoted to custodial and infirmary care.

The institution is in plan a combination of the cottage and segregated pavilion types—

House of the Good Samaritan.

separate buildings of varying size and disposition for the different classes of patients. Non-restraint, much open air freedom and industrial training are features of the management.

HOUSE OF THE GOOD SAMARITAN

The House of the Good Samaritan, located at the corner of Francis and Binney streets, is under the government of the association of the same name, and was incorporated in 1860.

Free care and medical treatment are given to white women and girls over two years of age; children from two to twelve with orthopedic diseases are also taken. The total number of beds is 64, divided as follows: 14 for chronic medical cases (paralysis not taken), 17 for pulmonary tuberculosis, 21 for cancer and 12 for orthopedic.

Patients are taken irrespective of creed or nationality.

LONG ISLAND HOSPITAL

The Long Island Hospital is situated in Boston Harbor, about five miles from the center of the city. It is a large general hospital of 400 beds with an isolated unit of 60 beds for segregating tubercular patients, and has two infirmaries with additional beds to accommodate 600; also a registered maternity hospital and nursery with usually 40 or 50 children. Four pavilions are now being erected with a capacity of 104 beds for the better segregation of patients.

The hospital offers exceptional clinical facilities in neurological, skin, venereal, and chronic diseases. A training school comprising 60 pupils is maintained in connection with the hospital, offering a two years' course of instruction.

MASSACHUSETTS CHARITABLE EYE AND EAR INFIRMARY

The Massachusetts Charitable Eye and Ear Infirmary was incorporated in 1827 for the purpose of gratuitously treating diseases of the eye and ear. It is thus the second oldest hospital in New England, and with its ward capacity of 215 beds, its large out-patient clinic and its special building for the treatment of contagious

Long Island Hospital.

ophthalmia, the largest hospital of its kind in the world.

The work of the out-patient department is carried on during the morning, with an average daily attendance of about two hundred patients, representing all the common occupations and coming from all over New England. The same staff attends these patients and the ward patients, thus securing a maximum of efficiency without unnecessary duplication of work in diagnosis and preliminary study. Nearly all the ward cases are admitted through the out-patient department and return there for further treatment after leaving the wards, so that the whole work of the hospital as carried on is directed to the complete and continuous treatment of each patient by the same group of surgeons.

In the wards 3,652 patients were treated last year, including 278 contagious cases treated in the Gardner wards, of whom 115 were infants. There were 3,287 operations in the out-patient department and 2,713 in the house.

All of the clinical work is carried on in the mornings and is so organized as to afford opportunity to visiting surgeons for observing its nature and scope.

PRELIMINARY CLINICAL PROGRAM FOR BOSTON MEETING

MASSACHUSETTS GENERAL HOSPITAL

Monday

C. A. PORTER — 9. Operations: Goiter, cancer of stomach.
D. F. JONES — 9. Operations: Cancer of rectum (first stage).
R. C. CABOT, HUGH CABOT, and OSCAR RICHARDSON — 10. Demonstration: Comparison of clinical evidence with post-mortem findings.
HUGH CABOT et al — 2. Operations: Epididymectomy for tuberculosis, litholapaxy for stone in bladder, ureterotomy for stone.
C. L. SCUDDER — 3. Demonstration: Fractures.
HUGH WILLIAMS — 3. Demonstration: Cases.

Tuesday

E. G. BRACKETT and R. B. OSGOOD — 9. Operations: Excision of knee, with bone plates, exploration of knee joint through median incision.
D. L. EDSALL — 10. Clinic: Border-line cases.
C. L. SCUDDER and H. F. HEWES — 10. Demonstration: Diagnosis and treatment of chronic gastric ulcer.
G. W. W. BREWSTER — 2. Operations: Hysterectomy for fibroids, appendectomy.
LINCOLN DAVIS — 2. Operations: Ureterotomy for stone, hysterectomy.
ROGER I. LEE and BETH VINCENT — 2. Demonstration: Splenectomy for pernicious anæmia.
C. C. SIMMONS — 3. Demonstration: Osteomyelitis.
G. A. LELAND, JR. — 3. Demonstration: Anthrax.

Wednesday

F. G. BALCH — 9. Operations: Prostatectomy, abdominal tumor.
R. B. GREENOUGH — 9. Operations: Benign tumor of breast, cancer of breast.
Z. B. ADAMS, M. S. DANFORTH, and C. H. BUCHOLZ — 10. Demonstration: Scoliosis.
L. T. BROWN — 10. Demonstration: Postural defects.
FARRAR COBB — 2. Operations: Hysterectomy for cancer (Wertheim).
HUGH WILLIAMS — 2. Operations: Gall-bladder.
R. C. CABOT, HUGH CABOT, and OSCAR RICHARDSON — 3. Demonstration: Comparison of clinical evidence with post-mortem findings.

Thursday

HUGH CABOT et al — 9. Operations: Nephrectomy for tuberculosis, pyelotomy for stone, prostatectomy.
R. C. CABOT — 10. Clinic: Border-line cases.
ABNER POST — 10. Demonstration: Congenital syphilis.
E. G. BRACKETT and R. B. OSGOOD — 2. Operations: Open operation on hip, gig-saw osteotomy of knee joint.
C. A. PORTER, A. K. STONE, H. F. HEWES, and J. B. HARTWELL — 3. Demonstration: Tuberculous cervical adenitis.
W. J. MIXTER — 3. Demonstration: Fracture of the skull.

Friday

C. L. SCUDDER — 9. Operations: Duodenal ulcer, cancer of stomach, fracture of femur.
R. B. GREENOUGH — 9. Operations: Cancer of jaw, tongue, or lip.
J. C. WARREN — 10. Demonstrations: Reminiscences of the discovery of ether.
C. A. PORTER — 10. Demonstration: Cases.
R. H. MILLER — 10. Demonstration: Tetanus.
C. A. PORTER — 2. Operations: Tuberculous cervical adenitis, operation on peripheral nerve.
D. F. JONES — 2. Operations: Cancer of rectum (second stage).

Surgical Specialities

A. COOLIDGE, J. P. CLARK, H. P. MOSHER, D. C. GREENE, W. F. KNOWLES, H. A. BARNES, C. ROBBINS, and F. E. GARLAND — Eye, ear, nose, and throat clinics, daily.
G. H. WRIGHT — Demonstrations in oral surgery.
J. L. GOODALE — Demonstration: The diagnosis and desensitizing of hay fever.

BOSTON CITY HOSPITAL

Monday

J. B. BLAKE, W. E. FAULKNER, and L. R. G. CRANDON — 9. Operations: Surgical.
F. S. NEWELL, E. B. YOUNG, and N. R. MASON — 2. Operations: Gynecological.
G. P. SANBORN — 3. Demonstration: End results in the tuberculin treatment of lymphnodular tuberculosis.
F. W. WHITE, F. B. LUND, and R. D. LEONARD — 4. Demonstration: Diagnosis and treatment of ulcer and cancer of the stomach (medical, surgical, X-ray).

Tuesday

F. B. LUND, F. J. COTTON, and D. D. SCANNELL — 9. Operations: Surgical.
PAUL THORNDIKE and assistants — 2. Operations: Genito-urinary.
PAUL THORNDIKE — 3. Demonstration: Prostatectomy, renal calculus.
HORACE BINNEY — 4. Demonstration: Treatment of tumors of the bladder with the high-frequency current.

Wednesday

E. H. NICHOLS, H. A. LOTHROP, and J. C. HUBBARD — 9. Operations: Surgical.
J. B. BLAKE, W. E. FAULKNER, and L. R. G. CRANDON — 2. Operations: Surgical.
J. B. BLAKE — 3. Demonstration: Splenectomy for Banti's disease.
A. R. KIMPTON — 4. Demonstration: Transfusion by the use of glass cylinders, bone tumors, resection of the stomach for sarcoma.

Thursday

PAUL THORNDIKE and assistants — 9. Operations: Surgical.
F. B. LUND, F. J. COTTON, and D. D. SCANNELL — 2. Operations: Surgical.
F. J. COTTON — 3. Demonstration: Artificial impactions in fracture of the hip, joint affections, separations of the lower epiphysis of the femur.
F. B. LUND — 4. Demonstration: Results of operative treatment of fractures, particularly with Parham and Martin bands.

J. H. CUNNINGHAM — 4:30. Demonstration: Congenital cystic kidney, results of operations for intestinal tuberculosis, nephrectomy for acute unilateral hæmatogenous infections of the kidney.

F. H. LAHEY — 5. Demonstration: Cardiospasm, carcinoma of the jejunum, resection of the rectum with perineal anus.

Friday

F. S. NEWELL, E. B. YOUNG, and N. R. MASON — 9. Operations: Gynecological.

E. H. NICHOLS, H. A. LOTHROP, and J. C. HUBBARD — 2. Operations: Surgical.

E. H. NICHOLS — 3. Demonstration: Results and methods of operating for osteomyelitis, cerebral surgery.

H. A. LOTHROP — 4. Demonstration: A new operation on the frontal sinus.

J. C. HUBBARD — 5. Demonstration: Sarcoma of the femur, excision of the transverse colon, perforation of duodenal ulcer, transverse duodenal removal of a gallstone, rupture of the liver.

In connection with the operative clinics, demonstrations of special methods of anæsthesia — intratracheal, spinal, etc. — will be given, where possible, by J. E. BUTLER, F. L. RICHARDSON, and N. N. MORSE.

CHILDREN'S HOSPITAL

Orthopedic Department

R. W. LOVETT, A. THORNDIKE, ROBERT SOUTTER, A. EHRENFRIED, A. T. LEGG, J. W. SEVER, and HENRY J. FITZSIMMONS — Daily, 9 to 11. Orthopedic operations: Reduction of congenital dislocation of the hip by various methods, and especially by a special machine; tendon transplantations, capsule reefing, etc., in infantile paralysis, the use of silk ligaments in infantile paralysis; the operative correction of club foot; the Hibbs and Albee operations for tuberculosis of the spine; the operative treatment for spastic paralysis; operations for coxa vara; bone transplantations.

R. W. LOVETT — Monday, 2:30 and 5:10. Demonstration: The treatment of infantile paralysis by muscle training, with exhibition of patients. The treatment of scoliosis by forcible jackets. Application of jackets and demonstration of results.

ROBERT SOUTTER and A. T. LEGG — Monday, 3:15. Demonstration: Exhibition of the results of the operative treatment of infantile paralysis.

E. G. MARTIN — Monday, 3:30. Demonstration: An apparatus to determine the strength of muscles affected by infantile paralysis, with conclusions to be drawn from observations made by it.

J. J. THOMAS and J. W. SEVER — Monday, 4. Demonstration: Obstetrical paralysis and fracture of the acromion process simulating it.
Monday, Tuesday, and Wednesday, 3. Demonstration: Treatment of paralysis by muscle training.

A. THORNDIKE — Monday, 4:30. Demonstration: End-results in osteoplastic operation for spinal tuberculosis.

PERCY BROWN — Monday, 4:50. Demonstration: Röntgen results in osteoplastic spinal operations.
Thursday, 4. Demonstration: Result of röntgen investigation in cases of fibrous stenosis of the pylorus in children.
Daily, 10 to 4. Exhibition of röntgenograms, röntgen department.

ROBERT SOUTTER — Thursday, 3. Operation: A new operation for flexion contraction of the thigh in infantile paralysis.

A. T. LEGG — Thursday, 3:30. Operation: Transplantation of the origin of the pectoralis major muscle in paralysis of the shoulder.

A. EHRENFRIED — Thursday, 2:30. Demonstration: Multiple enchondroma.

H. J. FITZSIMMONS — Monday, Tuesday, and Wednesday, 3. Demonstration: Treatment of scoliosis with methods in use; cases and records.
Thursday, 4:20. Demonstration: Apparatus for reduction of congenital hip dislocations.

PROFS. ERNST, FOLIN, HUNT, CANNON, and WOLBACH, DRS. STONE and MORSE — Thursday, 4:30. Clinic: Infantile paralysis.

Visit to orthopedic wards daily, 11 to 12. The new hospital buildings will be open to inspection by visitors daily, 9 to 10.

Surgical Department

J. S. STONE, W. E. LADD, C. G. MIXTER, and T. W. HARMER — Daily, 11 to 1. Surgical operations: Harelip, cleft palate, empyema, hernia, cervical adenitis, webbed fingers, hypospadias, undescended testis, etc.

C. G. MIXTER — Tuesday, 2:30. Demonstration: Imperfect and ectopic anus.
Wednesday, 2:30. Demonstration: Tuberculous peritonitis; pyloric stenosis; undescended testis.

W. E. LADD — Tuesday, 2:30. Demonstration. Cervical adenitis.
Wednesday, 2:30. Demonstration: Intussusception; harelip and cleft palate.

J. S. STONE, W. E. LADD, and J. J. THOMAS — Tuesday, 2:30. Demonstration: Fractures in children, subperiosteal and epiphyseal, elbow joint fractures, Volkman's ischæmic contractures.

J. S. STONE — Wednesday, 2:30. Demonstration: Some obscure abdominal conditions; empyema, harelip, and cleft palate, acute epiphyseal lesions.

T. W. HARMER — Wednesday, 2:30. Demonstration: The treatment of birthmarks.

PROFS. ERNST, FOLIN, HUNT, CANNON, WOLBACH, DRS. LOVETT, STONE, and MORSE — Tuesday, 4:30. Clinic: Cervical adenitis.

DRS. CROSBY, GREENE, and F. E. GARLAND, three afternoons. Eye, ear, nose, and throat clinic.

Visit to general surgical wards daily, 10 to 11.

MASSACHUSETTS HOMŒOPATHIC HOSPITAL

Monday

A. G. HOWARD and H. MOORE — 9. Orthopedic operations: Bone grafting, tendon transplantation.

J. H. PAYNE and D. W. WELLS — 9. Eye operations: Advancement, pulley stitch; advancement, modified Worth; ptosis, Tansley operations; trephining, glaucoma.

DRS. RICE, HOUGHTON, and C. SMITH — 2. Operations: Nose and throat.

W. F. WESSELHOEFT and T. E. CHANDLER — 2. General surgical operations: Gastric ulcer, ventral hernia, inguinal hernia, appendicitis, œsophageal diverticulum.

Tuesday

J. E. BRIGGS and C. T. HOWARD — 9. General surgical operations: Prostate, appendix, goiter, inguinal hernia.

G. A. SUFFA and A. W. HORR — 9. Eye operations: Muscle tucking; advancement, modified Worth; cataract extraction; glaucoma.

HORACE PACKARD and C. T. HOWARD — 2. General surgical operation: Appendectomy, a simpler method of sealing the appendicular stump. Demonstration cases: Prostatectomy, the choice of routes; the control of post-operative hæmorrhage, illustrative operations; empyema, cases for demonstration; enteroptosis, cholelithiasis.

DRS. RICE, HOUGHTON, and SMITH — 2. Operations: Nose and throat.

Wednesday

DRS. RICE, HOUGHTON, JOHNSON, SMITH, and BUSH — 9. Operations: Nose and throat.

GEORGE H. EARL and H. MOORE — 9. Orthopedic operations: Congenital dislocation of the hip, bone-grafting, tendon transplantation.

W. F. WESSELHOEFT and R. C. WIGGIN — 2. General surgical operations: Nephrolithiasis.

F. W. COLBURN — 2. Operations: Ear.

Thursday

J. E. BRIGGS and C. Crane — 9. General surgical operations: Cancer of the breast, appendix, cholelithiasis, nephrolithiasis.

DRS. RICE, HOUGHTON, and C. SMITH — 9. Operations: Nose and throat.

G. R. SOUTHWICK — 2. Gynecological operations: Ovarian cystomata, retrodisplacement of uterus, uterine fibromata, perineorrhaphy.

Friday

G. R. SOUTHWICK and D. G. WILCOX — 9. Gynecological operations.

DRS. A. S. BRIGGS, BOYD, LEE, SEDGELEY, SOUTHER, and THOMAS — 2. General surgical operations.

Demonstrations

W. H. WATTERS — Surgical pathology.

G. A. SUFFA — Ophthalmotrope.

Routine examination of ante-partem cases — Wednesday, 10.

Social service clinic for post-partem cases — Thursday, 2.

Daily clinics in twilight sleep.

Daily exhibition of new maternity building.

PETER BENT BRIGHAM HOSPITAL

HARVEY CUSHING — Daily. Clinics or demonstrations: Surgery of the brain, pituitary body, spinal cord, peripheral nerves.

DAVID CHEEVER and JOHN HOMANS — Daily. Operations: Surgical.

HENRY A. CHRISTIAN, CHANNING FROTHINGHAM, and others of the medical staff will coöperate in giving clinics or demonstrations on selected topics, such as the electrocardiogram, etc.

FREE HOSPITAL FOR WOMEN

DRS. GRAVES, PEMBERTON, WADSWORTH, HUTCHINS, and BAKER — Tuesday, Wednesday, and Thursday, 9. Operations: Gynecological.

DR. PEMBERTON — Wednesday, 2:30. Cystoscopic demonstration.

DR. HUTCHINS — Thursday, 2:30. Demonstrations: Laboratory specimens.

ST. ELIZABETH'S HOSPITAL

DRS. LANE and SUPPLE — Monday and Thursday, 9. Operations.

DR. M. J. CRONIN — Monday, Thursday, and Friday, 10. Ward visit.

Wednesday, 9. Intravenous salvarsan injections.

DR. T. F. BRODERICK — Tuesday, 9. Orthopedic operations and clinic.

DR. A. L. CHUTE — Wednesday and Friday, 9. Operations: Genito-urinary.

DRS. BRAINERD and HOLMES — Tuesday, 9. Nose and throat clinic.

DR. A. F. DOWNING — Monday and Friday, 11. Demonstrations: Laboratory technique.

DR. P. F. BUTLER — Tuesday and Thursday, 10. Demonstration: Radiography.

DRS. MCDONALD and MCADAMS — Wednesday, 10. Eye clinic.

The history, diagnosis, and indication for operation in each case will be discussed previous to operation by Dr. Cronin of the medical service and Dr. Butler of the röntgenological department.

ROBERT BRIGHAM HOSPITAL

CHARLES F. PAINTER, EDWARD RICHARDSON, LLOYD T. BROWN, and RICHARD MILLER — Tuesday and Thursday — 10. Operations.

Monday, Wednesday, and Friday, 3. Clinics: Surgery of chronic diseases, arthritis, intestinal tuberculosis, peritoneal adhesions, hæmolytic diseases.

NEW ENGLAND HOSPITAL FOR WOMEN AND CHILDREN

MARY A. SMITH and ABBY M. O'KEEFE — Monday and Thursday, 10. Operations: Gynecological.

ELIZABETH T. GRAY and LETITIA D. ADAMS — Monday, 2; Tuesday, 10. Operations: Gynecological.

EMMA B. CULBERTSON and GLADYS COOPER — Tuesday and Friday, 2. Operations: Gynecological.

FLORENCE DUCKERING and LETITIA D. ADAMS — Wednesday, 10.

Thursday, 2. Operations: Gynecological.

MAUDE CARVILL — Thursday, 2. Eye clinic.

MARGARET NOYES — Wednesday, 2. Ear, nose, and throat clinic.

ISABELLE D. KERR — Friday, 10. Ear, nose, and throat clinic.

Scopolamine-morphia anæsthesia both with and without ether will be used during these clinics. Statistics, covering six years' continuous use of this form of surgical anæsthesia, on over 1,400 cases, are available. Dr. Abby M. O'Keefe, professional anæsthetist, has entire charge of this department.

LONG ISLAND HOSPITAL

F. H. LAHEY — Monday, 2. Operations.

J. H. CUNNINGHAM — Tuesday and Wednesday, 2, Operations.

ROBERT SOUTTER — Thursday and Friday, 2. Operations.

CARNEY HOSPITAL

J. T. BOTTOMLEY and D. F. MAHONEY — Monday, Wednesday, and Friday, 9. Operations: Surgical.

W. R. MACAUSLAND and A. R. MACAUSLAND — Monday, Wednesday, and Friday, 9. Operations: Orthopedic.

F. W. JOHNSON and S. RUSHMORE — Tuesday and Thursday, 9. Operations: Gynecological.

CODMAN HOSPITAL

E. A. CODMAN — Tuesday, 10. Operations: Surgical. Demonstration of lesions about shoulder joint. Thursday, 10. Operations: Surgical. Demonstration of lesions of duodenum.

HOUSE OF THE GOOD SAMARITAN

DRS. SOUTTER, LEGG, and SEVER — Monday, Wednesday, and Friday, 10. Clinics: Infantile paralysis, muscle transplantation, flattened condition of the head of the femur, obstetrical paralysis.

TUFTS MEDICAL SCHOOL

A. W. GEORGE — Daily, 2 to 5. Demonstrations: Röntgenology.

MASSACHUSETTS CHARITABLE EYE AND EAR INFIRMARY

DRS. CROCKETT, MOSHER, and EMERSON — Monday and Friday. Otological clinic.
DRS. JACK, WALKER, POWERS, and BLODGETT — Tuesday. Otological clinic.
DRS. HAMMOND, WHITE, and FAUNCE — Wednesday. Otological clinic.
DRS. JACK, KNOWLES, TOBEY, and BOGAN — Thursday. Otological clinic.

Eye clinic daily from 9 to 12. Various operations on lids, tear sac, and muscles of the eye. Different types of operation for cataract and glaucoma. Magnet operations for the removal of foreign bodies from the eye. Different methods of using local anæsthesia. Tuberculosis of the eye. Interstitial keratitis of specific origin. Ophthalmia neonatorum and gonorrheal ophthalmia in adults. Localization of foreign bodies in the eye by the X-ray. Demonstration of ophthalmometer for measuring astigmatism of the lens. Demonstration of lantern slides by pathological department.

BOSTON DISPENSARY

H. M. CHASE and H. F. DAY — Surgical clinic.
JOHN ADAMS — Orthopedic clinic.
HENRY J. PERRY and ARTHUR H. CROSBY — Genito-urinary clinic.

FORSYTHE DENTAL INFIRMARY

FRED B. LUND — Monday, 9. Surgical operations.
HARRY H. GERMAIN — Tuesday, 9. Surgical operations.
HUGH WILLIAMS — Wednesday, 9. Surgical operations.
HUGH CABOT — Thursday, 9. Surgical operations.
WILLIAM E. CHENERY and LOUIS ARKIN — Daily, 10. Nose and throat clinic.
L. M. S. MINER — Tuesday, 2. Oral surgery.
HARRY B. SHUMAN — Wednesday, 2. Oral surgery.
ALBERT L. MIDGLEY — Thursday, 2. Oral surgery.
DR. STROUT — Friday, 2. Oral surgery.
ALBERT KINLEY, JR. — Daily, 11 and 2. Radiography.
WILLIAM A. GOBIE — Daily, 11 and 2. Extracting clinic.
WILLIAM Z. HILL — Daily, 9 and 2. Operative dental clinics.
FRANK A. DELABARRE — Daily, 9. Orthodontia clinic.

Research Laboratory will be open from 9 to 12 and 2 to 4 daily. Exhibition of pathological and bacteriological specimens.

HARVARD MEDICAL SCHOOL

PROFS. COUNCILMAN and MALLORY — Demonstration: Pathology.
PROFS. CANNON and W. T. PORTER — Demonstration: Physiology.
PROF. FOLIN — Demonstration: Chemistry.
PROF. STRONG — Demonstration: Tropical Medicine.
PROF. REID HUNT — Demonstration: Pharmacology.
DRS. ORDWAY and TYZZER — Demonstration: Cancer research.
JOHN WARREN — Demonstration: Anatomy.
W. F. WHITNEY — Demonstration: Warren anatomical museum.
F. T. LEWIS — Demonstration: Embryology.
J. E. GOLDTHWAIT — Demonstration: Visceroptosis.